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Electrical World

SEPTEMBER 13, 1947

A SPECIAL ENGINEERING REPORT

Insulated Aluminum WIRE AND CABLE

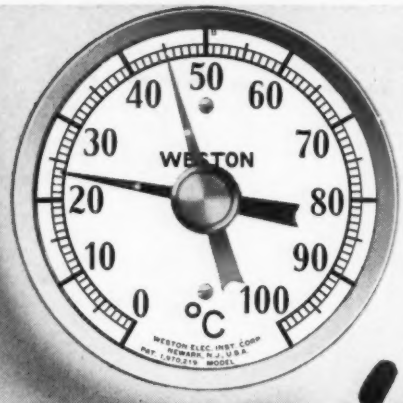
BASIC PHYSICAL PROPERTIES

CONDUCTOR VOLTAGE DROP

BUS-BAR LAPS AND JOINTS

INSULATION, CARRYING CAPACITY

McGRAW-HILL PUBLICATION



MAX-MIN MODEL—Shows high or low temperatures reached since last setting

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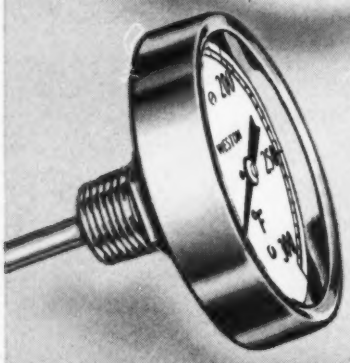
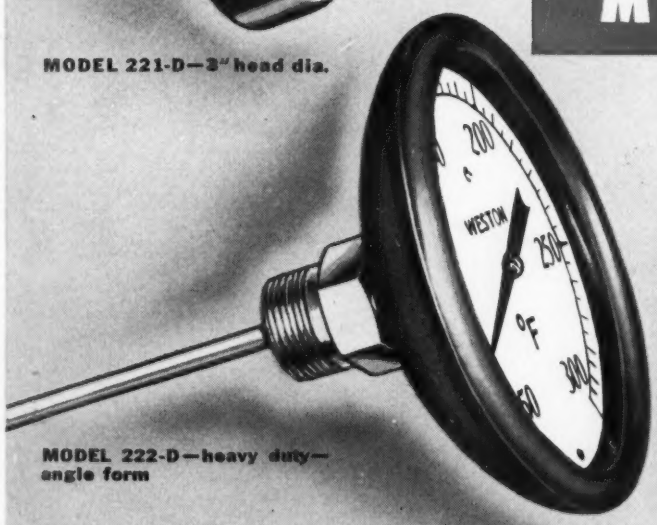
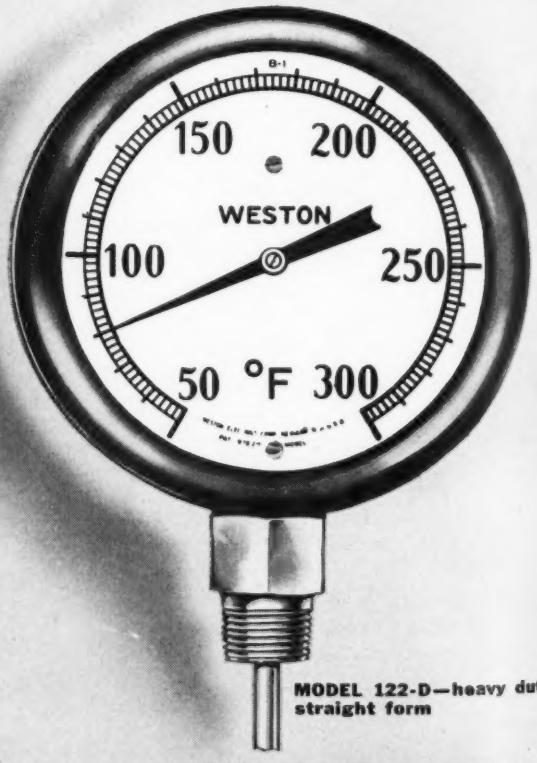


MODEL 221-D—3" head dia.



MODEL 222-D—heavy duty—angle form



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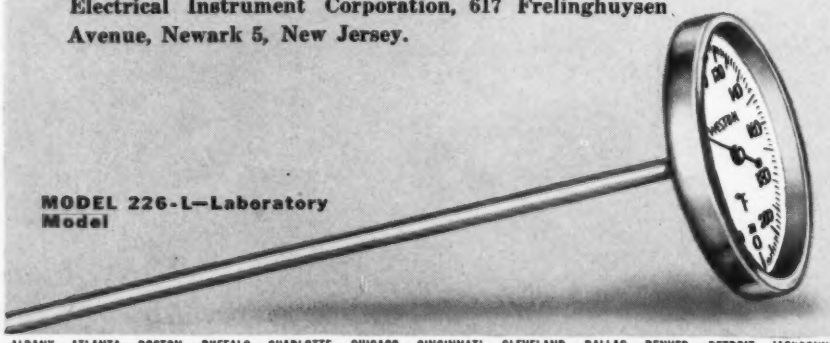

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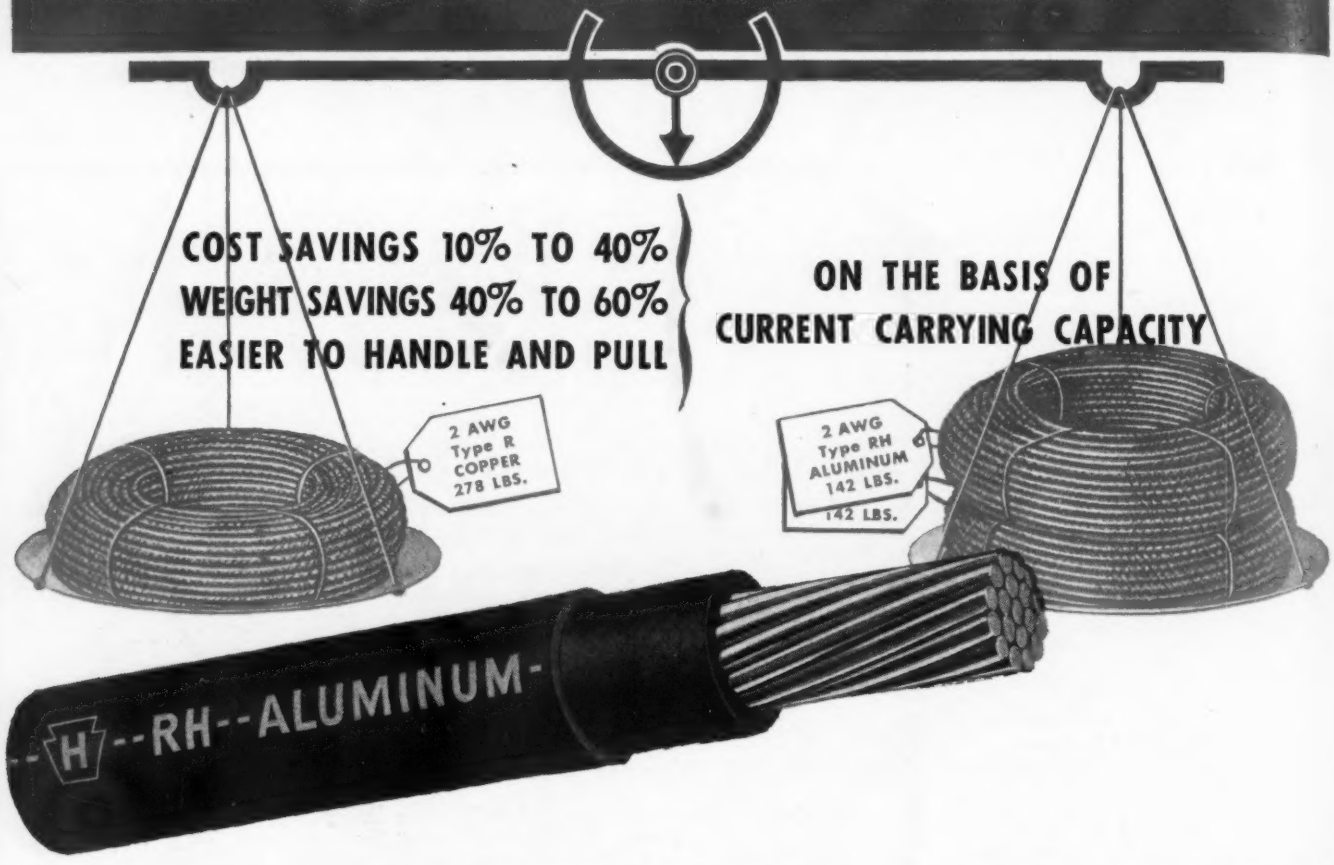

EVEN though Type RH Performite heat-resisting insulation – standard for Hazard Aluminum Building Wire – is superior to Type R Code-Grade insulation, so widely used on copper conductors, its higher cost is more than offset by the low cost of the aluminum, which goes three times as far as copper on a weight basis. Further savings can be made in handling and installation costs, too, because coils and loaded reels weigh less, and wire requires less pulling effort.

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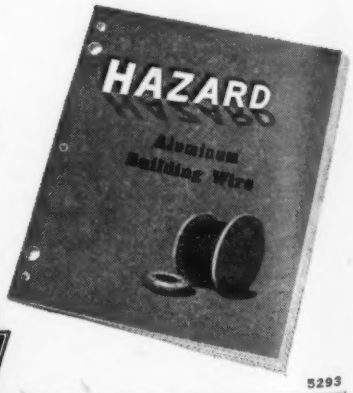
Write for Bulletin H-407-AL which contains tables, calculating data and details of simple splicing and terminating methods.



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Electrical World

SEPTEMBER 13, 1947

Atoms at the Busbar?

FOR two years, now, the possibility has been clear that the world may one day generate and enjoy atomic-electric power. For almost that long, the entire electric power industry has pondered its probable shape when that day arrives. There has been speculation as to the technology of that era, and as to the control devices which the public will deem necessary then.

We have just observed one of the most definitive assertions of record on public control of atomic-electric power. It was made by Chairman David E. Lilienthal, of the Atomic Energy Commission. It came before the United Nations Atomic Energy Commission. An extract, as reported in the August "Bulletin of the Atomic Scientists," follows:

". . . some consideration might be given to the policy, as I understand it, that is expressed, or certainly implied, in the Atomic Energy Act of 1946 . . . in respect to large power reactors.

"That is a reactor yet to be built, yet to be designed, but a reactor which will undoubtedly some day be designed and built, which may be capable of producing heat which can be transferred to a conventional steam turbine, and, by that turbine, produce electricity through a conventional generator. This large reactor, being dangerous in terms of security, would, on the proposals made, be designed, owned and managed by the International agency. Similarly, and prior to that time, such a reactor—if international agreement has not by that time been reached—such a large reactor, producing electricity, would be designed, owned, managed and operated by the Atomic Energy Commission of the United States.

"But under the act of Congress, it by no means follows that because the reactor itself must be kept under the ownership, management and operation of the AEC, the electricity produced by this reactor must be distributed by the AEC or the government. I rather infer, from certain provisions of this law, that the contrary may well be approved by Congress; namely that at the busbar, at the point where the electricity is produced by the generator, it will then be transferred for distribution to whatever kind of agency is the policy of that region or locality, or whatever the national policy may be in that respect; that it may be transferred to a State, . . . or to a private industry, or a public utility privately owned, or any one of a number of distribution agencies, depending upon the wishes of the people at that point. The fact that the production must be in national hands . . . does not require that the distribution should likewise be other than in accordance with the desires of the people of the local region or community."

The problem discussed here is basic to any thinking about atomic-electric power. Whether one agrees or not with Mr. Lilienthal's assumptions—we will state our position later—we believe that this statement merits the broadest possible study by anyone who would visualize the shape of public control of atomic-electric power.

NEWS OF THE

New Instrument Developments Exhibited at Chicago Show

Over 8,500 Utility and Industrial Engineers Attend Second National Conference—140 Companies Have Exhibits—Devices Displayed Include Inkless Recorder, Smoke Control System

More than 8,500 utility and industrial engineers registered, attended the exhibit, and took part in the Second Instrument Conference held this week in Chicago under sponsorship of the Instrument Society of America. The registration was nearly double that of the first conference held in Pittsburgh last year. The number of exhibitors increased about 50 percent to 140, and the papers covered a larger scope of the science of instrumentation.

Among the new developments shown at the instrument show were a motor-driven pen on recording instruments, a 250-deg scale on switchboard instruments, a low cost system of remote indication, an inkless recorder, a system of smoke control, and an electronic analyzer for electronic instruments.

The motor which powers the pen on the new Wheelco Capacilog drives both the follow-up vertical shaft and the scriber spiral simultaneously. This is accomplished through worm gears and a spur gear arrangement. Backlash is eliminated by a copper beryllium follower on the pen which assures the pen instantly and continuously following the indicator.

General Electric Co displayed a new line of 250-deg scale volt and ampere meters, and a new recorder which utilizes a typewriter ribbon and a vibrator in place of ink. It also displayed a Selsyn device for remote indication of temperature, pressure, liquid level, flow, speed, weight and position.

Photoswitch, Inc, showed a smoke density control unit which is composed of a photoelectric light source, a pick-up unit, three warning lights, and an alarm. The yellow light indicates excess air, the green efficient combustion, and the red excessive smoke. In parallel with the red lamp is an audio alarm.

The Weston electronic instrument analyzer is an electronic voltmeter with a resistance of 10,000 ohms per volt. It has an rf probe for measuring high-frequency potentials up to 300 megacycles. It also has a d-c probe for measuring d-c potentials in the presence of a-c potentials. It can be used with circuits from 50 cycles to 300 megacycles.

A new technique in preserving and displaying small component switch and meter parts was shown by Vernon-Benshoff Co of Pittsburgh. It consists of casing the parts in a clear plastic called vernonite.

In the conference sessions, A. Bayard Sisson, station efficiency engineer, Public Service Co of Northern Illinois, stated, "We feel that the purchase and installation of precision instruments with proper and precise calibration, and with intelligent use, will secure results which are reproducible and accurate."

In concluding his paper, entitled "Instrumentation in Turbine Testing," he added, "the careful training and instruction of test personnel through planning of test procedures, and arrangements and discussion with the operating force, all aid materially in securement of satisfactory test results."

W. C. Fortney, Humble Oil Co. in discussing the "application of conventional industrial instruments to power plant control" described two installations of high-pressure boilers and their water-conditioning supply plants. Considerable flexibility of steam generating plant was obtained in each instance by adapting the valves and controllers for remote positioning or control by conventional instruments.

TVA Stamps?

Stamp collectors of the Tennessee Valley have asked the Post Office Department to issue a series of commemorative stamps honoring TVA — "this world - renowned national achievement."

The TVA issue was proposed by the Wilson Dam Stamp Club of Knoxville, Tenn. In a letter to Postmaster General Hannegan, the club suggested that the series includes ten pictorial stamps, ranging in value from one to 10 cents.

Postal officials said they had filed the request for later consideration. The department has received several other appeals for TVA stamps in recent years, they revealed.

BPA Power to Go Over Lines of Pacific Power

Bonneville Power Administration and the Pacific Power & Light Co have reached an agreement by which Bonneville power will be moved over the utility's lines to serve publicly owned distribution systems.

The arrangement is a temporary one until BPA can get funds from Congress to erect its own transmission lines.

The power will go to the Columbia County Rural Electric Association, Dayton, Wash.; Wasco Electric Cooperative, The Dalles, Ore.; Eastern Oregon Electric Cooperative not operating; Columbia Basin Electric Cooperative, Hepner, Ore.; Klickitat County Public Utility District, White Salmon, Wash.; and Benton County Public Utility District, Prosser, Wash.

Utilities Board Abolished

The Public Utilities Board of Bessemer, Ala., has been abolished by the City Commission. City Attorney Edward L. Ball had ruled that the board was liquidated when the city commission form of government went into effect last February 1. Commission President Joe F. Lewis has taken over the administration of the city-owned light and water utilities.

ELECTRICAL WORLD ★ ★

Congressional Committee Will Study Lincoln Plan

Incentive Plan of Firm Making Welding Supplies Widely Known —Taft-Hartley Act Scrutiny On

The Congressional spotlight will be focused this winter on the much-publicized incentive plan of the Lincoln Electric Co, Cleveland, makers of welding equipment.

The Joint Congressional Committee set up under the Taft-Hartley Act to watch the operation of this law and to study controversial issues in labor relations, plans to examine the Lincoln incentive system and give it more publicity.

The study will be in accordance with the committee's mandate from Congress to study "the means by which the individual employee may achieve greater productivity and higher wages, including plans for guaranteed annual wages, incentive, profit-sharing, and bonus systems."

The committee, headed by Sen. Joseph H. Ball of Minnesota, will, on October 7 and 8, hold its first meetings since the new law became fully effective August 22. Tentatively, hearings will begin in late November or early December.

It must report by March 15 any recommendations for changes in the Taft-Hartley Act or for new legislation in the labor field. The final report is due January 2, 1949, when the next president is reading his message to Congress.

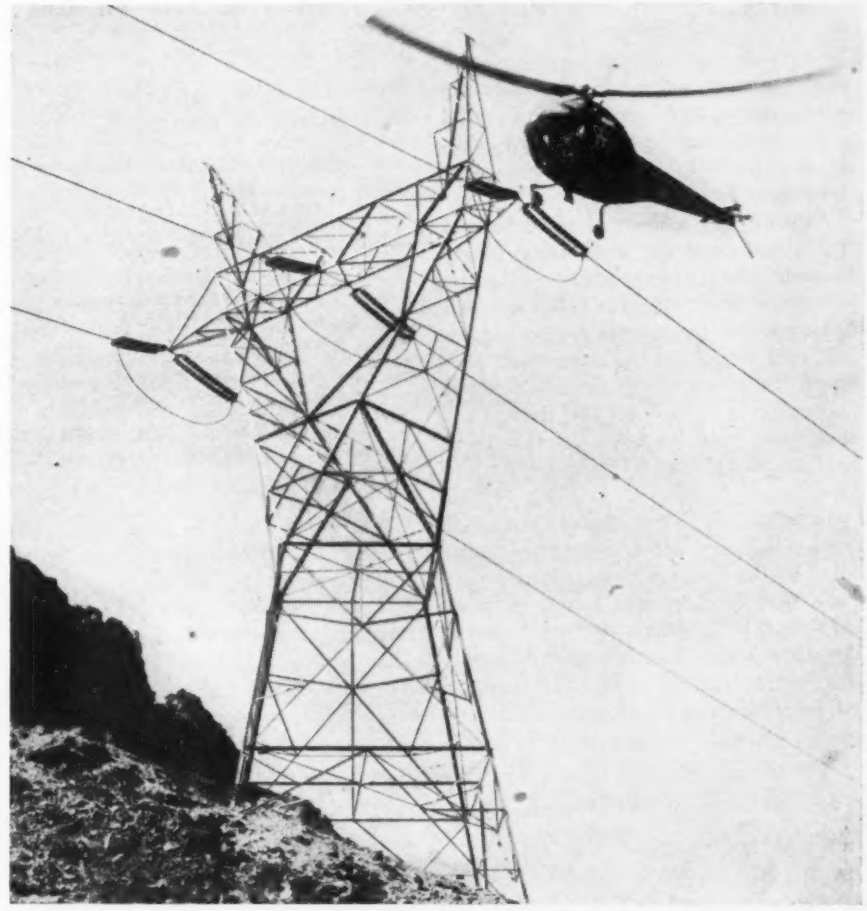
Right now, no member of the Joint Committee has indicated need for new legislation. Ball, in fact, feels that the law is working "very well" and sees nothing yet that needs changing.

Government, management, or labor officials who look to the Joint Committee for clarification of disputed points in the new labor law probably will get no satisfaction from the committee. The intention now is to leave interpretations to the courts, which really are the only competent authority. Opinions of the committee of individual members of Congress would be gratuitous and carry no weight in court.

One court decision was rendered this week on the question of non-Communist affidavits. In a case involving the Deep Oil Development Co, Wichita Falls, Tex., and the CIO Oil Workers Union, Federal Judge T. W. Davidson of Fort Worth ruled in effect that NLRB General Counsel Robert N. Denham was correct in ruling that officials of the CIO must file affidavits in order to qualify any affiliated union under the law. He refused to order the regional NLRB to count bargaining election ballots which were cast before August 22, but which have been impounded since then pending the filing of the necessary non-Communist affidavits.

The five members of NLRB have yet to consider the question on an appeal. Even then, final answer as to the law's meaning may have to await a decision from a higher court.

In an interview, Senator Ball said it was not the intent of those who wrote the law to include officers of the AFL and CIO central bodies among the union officials who must file affidavits denying Communist affiliation or sympathies. This is disputed by Rep. Fred A. Hartley, Jr., co-author of the law.



HOVERING OVER a transmission tower near Hoover Dam is helicopter leased by the Los Angeles Department of Water & Power for special patrol work on more than 500 miles of lines serving the city. The plane and another will be tested for four months. They will augment regular automobile patrols

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Ray Palmer Dies

Ray Palmer, retired New York consulting engineer on utilities, died on September 9 at Daytona Beach, Fla., where he made his winter home. Mr. Palmer had been president and general manager of the New York & Queens Electric Light & Power Co in New York from 1915 to 1925.

Shortage of Cars May Cause Utilities Coal Shortage Later

FPC Reports Electric Companies Had 77 Days' Stock on Hand on Aug. 1—TVA Gets Government Aid in Obtaining Deliveries —Great Lakes Region Generally Appears in Safe Position

THOUGH their coal stocks generally are better than at any corresponding period of the past several years, electric utilities may yet feel the pinch of the present shortage of railroad cars.

Already the Tennessee Valley Authority, using its steam generating plants to meet heavy peak loads while the Tennessee River's flow is below normal, has appealed for federal aid in obtaining coal deliveries. The appeal produced the allocation of some additional railroad cars in the past few days. TVA spokesmen said the move brought their coal stocks up from a "dangerously low level."

In addition, latest figures on coal stocks held by electric utilities compiled by the Federal Power Commission show that by August 1 stocks in most areas had fallen below the July 1 peak. On July 1, the nation's electric utilities had a total of 18,461,477 tons, or an 84 days' supply, on hand. On August 1, this total had dropped to 17,377,943—77 days' supply.

Danger in the Future

While these totals still amount to a comfortably safe margin, any tightening of the car shortage will drag them down farther during the peak load periods which are certain to continue. The present car situation, according to Office of Defense Transportation officials, is about as follows:

The government already has used its remaining controls to increase the general supply of open-top cars. Banks of cars carrying coal to lower Great Lakes ports for transshipment northward have been cut to 20,000 from a previous range of 22,000 to 26,000 per day. Hampton Roads, banking an average of 12,000 cars a day for water shipment of coal abroad and coastwise, has been cut to 10,000 a day.

All these cars have not been diverted to shipping coal to other areas. They have been made available for all types of freight, including coal, building materials, ore, and steel products. ODT feels that it lacks authority to discriminate between commodities in the allocation of cars. For that reason, it probably will not order that open cars be diverted to carry coal, unless the President declares an emergency.

Electric Utilities' Stocks

FPC estimates of comparative coal stocks held by electric utilities follow:

Area	August 1 Tons*	August 1 Days	July 1 Tons*	July 1 Days
New England	1,215	104	1,284	117
Middle Atlantic	5,689	89	5,990	93
East North Central	6,527	71	6,846	75
W. North Central	1,020	69	1,002	72
South Atlantic	1,988	66	2,302	80
E. South Central	619	69	697	78
W. South Central	139	173	147	264
Mountain	166	77	181	83

*Thousands of tons

The Great Lakes Region, which must receive its winter coal supplies before freezing weather, generally appeared in a safe position. Minnesota companies had smaller stocks than last year—274,452 tons as against 344,618 tons on August 1, 1946. But this August's total was slightly above the July, 1947, figure. Michigan and Wisconsin stocks were up.

•

Utility and New York City Agree on Hydro Project

Central Hudson Gas & Electric Corp, Poughkeepsie, N. Y., has filed with the Federal Power Commission a declaration of intention to construct a hydroelectric generating plant. The site is adjacent to the Roundout Reservoir of the New York City water supply system.

The utility and the city propose to enter a contract giving Central Hudson the right to operate the plant and connect it with the utility's transmission system for 50 years from the start of operation.

Central Hudson is to receive without charge an average of 3,200,000,000 cu ft of water annually. If more water is desired, the utility will be allowed to buy it at $26.50 per million cubic feet. This price can be adjusted at ten-year intervals.

In turn, the city will get free power for the operation of the Delaware water supply system. At the end of 50 years the plant and appurtenant equipment becomes city property.

Pacific G&E Makes Deal to Buy Power from Navy

To Get Surplus from Mare Isle Plant in Northern California— No Block of Power too Small

Pacific Gas & Electric Co has reached an agreement with the Navy for purchase of surplus power from Mare Island's steam generating plant in Northern California to supplement its tight power supply, utility officials announced last week.

Between 3,000 and 4,000 kw will be available from the plant in daytime and from 8,000 to 10,000 kw at night, the company said.

The western utility, recently forced to cut "dump" power sales to three chemical companies to maintain a source for its firmpower customers, (ELECTRICAL WORLD, August 30, Page 36) has been adding to its supply wherever it can, buying blocks as small as 150 kw from industrial power plants and other sources.

Larger blocks are being purchased from the Palo Alto Municipal Utility District and from Letterman General Hospital, San Francisco.

Conversations with the Navy had investigated the possibility of using power output from some of the larger military ships and carriers in the area, PG&E said. But all electric drive vessels suitable for the purpose are in active Navy operations at the present time.

Late last year the company put the power plant of a wrecked tanker, *SS Donbass*, to work at Eureka, Calif., to add 67,000 hp to the system in that area.

The cut in power available for Dow Chemical Co, one of the three curtailed and principal supplier of chlorine for municipalities in California and neighboring Southwest states, has resulted in the cessation of chlorination operations at Hyperion sewage plant in Los Angeles County. This meant the re-enforcement of a beach quarantine 4½ miles long, lifted earlier this summer when chlorine treatment had reduced pollution, stretching the quarantined area to a former 12 miles.

•

Can Retail Appliances

Judge J. Robert Martin, Jr, has ruled that Greer, S. C., has the right to engage in the retail sale of appliances and install a service and repair department in connection with the operation of its municipally owned utilities system. Opposition had been expressed by dealers.

Go All Electric Program Gets Support of Rocky Mt. League

Gadsby Warns against Communism, Says Nationalization Can Happen Here as It Did in England—Collins Claims Selling Job Needs Advertising and Promotion—Bullock New President

Go All Electric was the theme of the annual meeting of the Rocky Mountain Electrical League held at Casper, Wyo., September 4-6. Presentation of the League's five-year Go All Electric Program received the unanimous financial endorsement of dealer, distributor, manufacturer, municipal utility, and private power company membership. Principal media for reaching the public in Wyoming, Colorado, and New Mexico, the three-state area covered by the League, will be a farm paper of large circulation, local newspapers, a large network radio station in Denver, and local radio stations.

George M. Gadsby, president of Utah Power & Light Co, decried the breakdown in individual initiative and the sweep of totalitarianism and Communism that has engulfed all Europe and may sweep here before we know it. We now have autocratic government versus individual initiative, said Gadsby, after tracing efforts to establish a nationwide system of TVA's, Columbia Valley, and other authorities.

It Can Happen Here

"Don't take for granted what has happened in England could not possibly happen in America. It can happen if politicians infected with Socialism or crypto-Communism virus are not challenged at every step. Watch England closely. Use every opportunity of driving home to the American public the faults, failures, and damaging effects of nationalization. Make it an important part of your educational campaign," he said.

In discussing sources of power, C. A. Powel, Westinghouse Electric Corp, showed how our oil resources are being rapidly depleted. However, he said that America has tremendous coal deposits. Despite atomic power developments, coal will be a major source of power in this country for the next 1,000 years. He sees great promise in transporting and utilizing the energy in coal by the liquefication process now being established commercially in the Pittsburgh area.

We must sell up to dollar value and not down to penny cheapness, said Ash Collins, originator of Reddy Kilowatt, in discussing the industry's Go All Electric Program. Every appliance we sell is either comfort giving or labor saving, which gives our industry a tremendous promotional advantage over the industries that sell luxury items, he said. We have been too factual and technical in our promotion. Instead, we must package and dramatize our story like our competition if we expect to compete in the mass market. "The mint is the only place money is made without advertising." Our selling job can only be done through awakened intensive advertising and promotion.

James A. Bell, Electromaster Inc, drove home the same theme. He warned against complacency in selling and said that with the tremendous manufacturing facilities that have been created, it is now only sheet steel that is retarding the greatest flow of appliances the industry has ever seen. Already, some of the pipe lines of supply are nearly full. The day is here when the industry must intelligently go to work and intensify its selling.

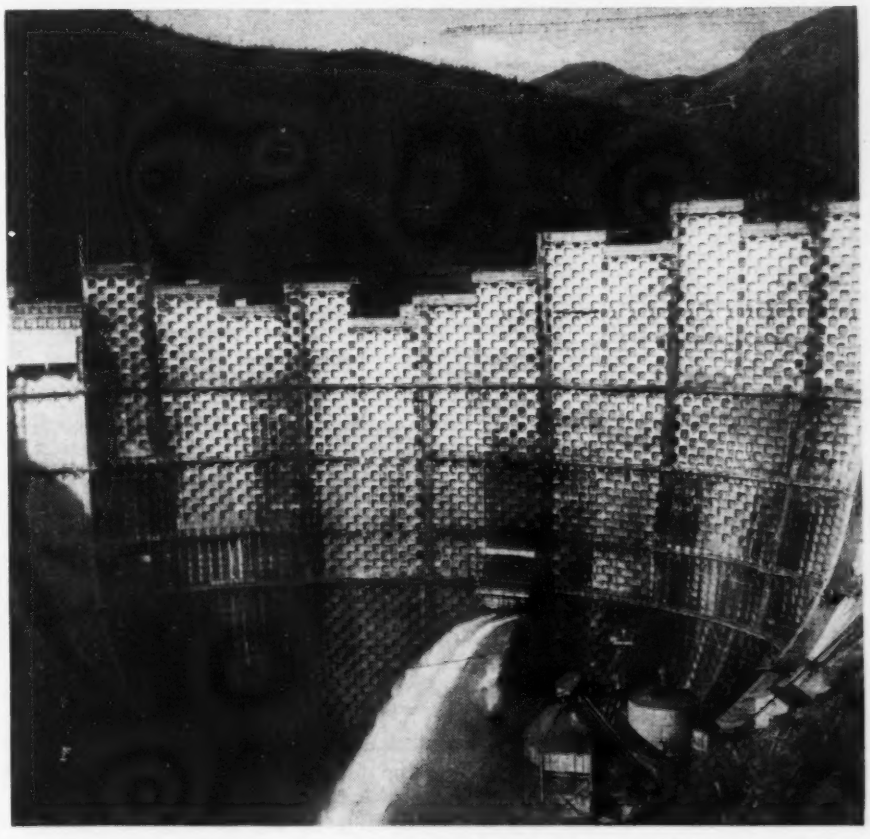
Greatest opportunities in the lighting field lie in improving brightness pattern and in use of color, declared G. B. Buck, II, Nela Park, in a demonstration talk. New tools are now available by which the industry can sell the EEI Planned Lighting Program. We now have 100 to 1,000 ft-c to shoot at. So far it is only a problem of economics.

J. A. Bullock, general manager, Western Colorado Power Co, was elected to succeed J. B. French, president of the Black Hills Power & Light Co, as president of the League.

•

Utilities Tax Passed

Tavares, Fla., has passed an ordinance imposing a tax on electricity, metered and bottled gas, water service, and local telephone and telegraph services. The tax is 10 percent on the first $25, 1 percent on balance of all payments over $25. The tax went into effect September 1.



WORK is now underway on the third step of Seattle City Light's Ross Dam. This is a part of the city's Skagit project. When completed the dam will be 540 ft high. It will take two more years to complete

Farmers Pay Utility's Bill; Power Restored in Area

Salt River Valley Waters Users' Association Cuts Off Power to Eloy, Ariz., Utility for 24 Hours

After 24 hours without power, central Arizona farmers served by the Eloy Light & Power Co pooled $61,000 last week so the company could pay the balance of a $67,600 overdue bill owed to the Salt River Valley Water Users' Association for power used in July.

A $3,000,000 cotton crop was jeopardized, and 60 huge pumps and two cotton gins idled during the cutoff.

Meanwhile a writ brought by seven Eloy district farmers which would have prohibited the Arizona Corporation Commission from passing on a request by the Eloy utility to raise rates was quashed in Maricopa County Superior Court. The Eloy company had asked the raise in order to meet increases levied by the Salt River Association.

Eloy's troubles stem from the widespread Arizona drought. The firm had a contract with the Water Users to supply it with electricity generated from the latter's hydroelectric plants. It did not renew the contract when it expired last November, but the Water Users continued to furnish power at contract rates until May when it became evident the drought would shut down generators at the Water Users' dams before the end of summer.

The association then withdrew its offer and billed the Eloy company at the higher prices paid for blocks of power purchased in California.

The Eloy company attempted to pass on this increase to the farmers it serves. When the plan met refusal there, it asked the corporation commission for permission to raise the rates.

Consumer protests were based on the grounds the company had not been managed efficiently or it could have weathered the higher wholesale cost of electricity.

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J. H. McGraw Contractors Award Given J. W. Collins

J. Walter Collins, secretary of the Electrical Contractors Association of the City of Chicago, this week received the James H. McGraw Award Contractors Medal for 1947. William T. Stuart, editor of *Electrical Construction and Maintenance*, made the presentation at a banquet held in connection with the annual meeting of the National Electrical Contractors Association at San Francisco.

The award was made for Collins' efforts in arousing contractors to combat the "labor only" contract and his development of compelling data proving such contracts are uneconomical and costly to the contractor and to the public.

Judges who made the award were A. Lincoln Bush, Belmont Electric Co, New York; Louis Freund, New York; E. A. Kahn, E. A. Kahn & Co, Jamaica, L. I.; Louis Kalischer, Louis Kalischer, Inc, Brooklyn; and W. T. Stuart, secretary of the Committee of Awards.

The award consists of a bronze medal and $100.

Values Differ

Savannah River Electric Co values at $2,025,000 the 3,829 acres of land which the government is condemning for the Clark Hill project. The government wants the land for $55,570.

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June Electric Energy Sales Rose 15.5 Percent

Sales of electric energy to ultimate customers in June, 1947, totaled 17,546,119,000 kwhr, compared with 15,185,008,000 kwhr in June, 1946, an increase of 15.5 percent, Edison Electric Institute reports.

Revenues from ultimate customers amounted to $309,630,500 in June, compared with $277,103,700 in June, 1946, an increase of 11.7 percent.

For the twelve months ended June 30, 1947, the average use per customer advanced to 1,385 kwhr from 1,290 kwhr for the preceding year, an increase of 7.4 percent; the average annual bill to $43.49 from $42.70, an increase of 1.9 percent; revenue per kwhr dropped to 3.14 cents from 3.31 cents, a decrease of 5.1 percent.

Classification of Sales, June, 1947, and Change from 1946

Kilowatt-Hour Sales June	Million Kwhr. 1947	1946	% Change
Residential or domestic...	3,369	2,954	+14.0
Rural (Distinct rural rates)	558	443	+25.8
Commercial or industrial			
Small light & power....	3,060	2,617	+16.9
Large light & power....	9,356	7,963	+17.5
Street & highway lighting.	154	147	+ 4.4
Other public authorities..	475	459	+ 3.6
Railways & railroads			
Street & interurban.....	345	342	+ 0.8
Electrified steam railroads	186	209	—10.8
Interdepartmental	44	51	—14.1
Total to ult. customers..	17,546	15,185	+15.5

Farm Conference Panels and Speakers Announced

Four panel discussions and talks by a number of persons prominent in the field of farm electrification will be the backbone of the National Farm Electrification Conference program. The conference will be held October 7-8, at the Claypool Hotel, Indianapolis.

The panel discussions and chairmen will be "Distribution and Servicing of Farm Electrical Equipment," Hugh Curtis, managing editor, *Successful Farming Magazine*; "Farm Wiring and Re-Wiring," J. R. Waters, rural service manager, Monongahela Power Co.; "Farm and Home Uses. Experimental and Research Work, and Unfilled Farm Equipment Needs," George A. Rietz, manager, Farm Industry Division, General Electric Co; and "Education and In-Service Training," J. H. McLeod, acting director, Agricultural Extension Service, University of Tennessee.

L. M. Smith, vice-president, Alabama Power Co, will speak on "Agricultural Development Activities by Power Suppliers," and REA Administrator Claude R. Wickard on "A New Era in Agriculture."

J. E. Stanford, executive secretary, Kentucky Farm Bureau Federation, will speak at the conference dinner on "The American Farmer Looks Ahead."

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NLRB Dismissed Pleas for Unions of Supervisors

A request of the Utility Workers of America, CIO, for bargaining rights among supervisors of Consolidated Edison Co of New York, was among 50 petitions involving supervisory personnel dismissed by the National Labor Relations Board. Under the Taft-Hartley Law, NLRB no longer may handle cases involving supervisors.

Other petitions dismissed involved Union Electric Co, St. Louis, and the International Union of Operating Engineers, AFL; Cincinnati Gas & Electric Co and the International Brotherhood of Electrical Workers, AFL; and National Electric Products, Ambridge, Pa., and IBEW.

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Higher California Values

California's Board of Equalization has estimated the value of private utilities in the state this year as 8.6 percent higher than in 1946. The board set the valuation for tax purposes at $1,233,353,040, compared with $1,135,635,520 for 1946.

EEI Accident Prevention Group Studies '46 Record

105 Fatalities Reported in Year —Lost-Time Accidents Increase —More Safety Aids Available

Implementation of accident prevention technique in recent-year activities of the Accident Prevention Committee of the Edison Electric Institute has accelerated to the point where the committee is seeking more channels for applying the hazard controls and educational precepts. At a two-day meeting in New York this week, it was emphasized that literature and visual aids had been made available. It is now a case of putting them to work with full industry cooperation.

Successful resuscitation in 182 cases from 1933 to 1946 reduced the fatality rate 17 percent, said W. R. Smith, Public Service Electric & Gas Co, Newark. In nearly half the life-saving instances the resuscitation was started within a minute. Smith's report is dedicated as a tribute to the trained employees who administered the treatments. In heartstring language it draws lessons from specific cases, both fortunate and pathetic.

Along somewhat similar educational lines were two visual presentations. One was a tentative version of Liberty Mutual's portrayal of the simple causes of electrical accidents in and about the home. The other was the same insurance company's sound-slide film "Let's Figure It Out," dramatizing D. C. Stewart's analysis of the five-year fatality record of the electric utilities. A. L. Dowden, who presented both, said the latter had already been shown to 40 groups of linemen in New England.

Michigan Educating Firemen

Michigan's State Board of Control is sponsoring an educational booklet about electrical hazards for firemen. It will be in simple pictorial style.

Whether to ground or not ground transformer cases is a moot question, as indicated by a survey by R. P. Douglas, Detroit Edison Co, among 107 companies with 2,254,803 pole-mounted transformers. The great majority ground on wye up to 7.5 kv and on delta above that voltage. Serious injuries appear to be the same whether or not the cases are intentionally grounded, but this will be referred to operating groups.

Employee cooperative self-training on the Idaho Power system is built around discussion within the work-crews of the potential hazards and sequence steps for each job before it is undertaken. E. E. Beck expects results in linework comparable to those achieved in power plant maintenance (ELECTRICAL WORLD, December 11, 1943, Page 65).

Of the 105 fatalities reported in 1946, there were 68 due to electric shock or burns; the 64.3 percent compares with 70.5 in 1941-45. Falls accounted for 18 fatalities, a slight percentage increase. Indications are that 1946 was generally downward as to fatalities in comparison with man-hours.

Lost-time accidents per million man-hours in 1946 were 14.81, a figure up 11 percent from 1945 and higher than any in 16 years. However the days lost per 1,000 man-hours gave a severity rate of 1.73, a drop of 12 percent because of the decrease in number of fatalities. Partial data reported for 1947 indicates that the year may turn out to be a bit better than 1946.

BOYSEN DAM, first of the key Bureau of Reclamation dams for harnessing the Missouri River's tributaries for power, irrigation, and flood control, will be built between the two sharp curves in the Big Horn River. The earthen structure will be about 150 ft high and 1,100 ft long at the crest

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Consolidated Mining Buys 3 West Kootenay Plants

Consolidated Mining & Smelting Co has bought three of the four power plants of its subsidiary. West Kootenay Power & Light Co. Consolidated has for many years used the entire output of the plants.

The plants purchased are South Slocum, 75,000 hp; Upper Bonnington, 84,000 hp; and Corra Linn, 57,000 hp. Consolidated already owns the 74,000-hp Brilliant plant. In addition to the 290,000 hp of capacity from these four plants, Consolidated will take most of the output of the 60,000-hp Lower Bonnington plant.

AFL Leaders Undecided on Filing Anti-Red Oaths

The old American Federation of Labor fear that the National Labor Relations Board would discriminate in favor of the Congress of Industrial Organizations affected the electric utility industry's labor picture this week.

In Chicago, where it met to consider filing anti-Communist affidavits, AFL's executive council delayed until the week's end any decision on the problem. But AFL President William Green was quoted as recommending the filings by members of the executive council. Green also predicted his recommendation would be approved.

The filings affect the electric utility industry because the largest union with which it must bargain—The International Brotherhood of Electrical Workers—will be unable to use the facilities of NLRB if the affidavits are not filed. This became clear recently under a ruling by NLRB's general counsel, Robert Denham. He held that all officers of parent organizations must file anti-Red statements before unions would be permitted to use NLRB.

The AFL executive council was to decide Friday whether to follow Denham's rule. The hesitation was based on a report that, because of certain organizational technicalities, certain CIO officials would not have to file the statements. The AFL officers insisted that these CIO officials hold corresponding positions to their own and should be treated similarly.

SEC RULINGS

DETROIT EDISON Co has been advised that its registration statement has become effective, covering a $60,000,000 bond issue. The commission has granted the company permission to issue an invitation for bids on the bonds. Proceeds of the issue will be used to retire all the $30,000,000 of 4 percent series F bonds now outstanding and to supply a portion of the funds needed for plant expansion, including repayment of about $12,000,000 borrowed from banks for such construction. (Release No. 7679).

ALLIED CHEMICAL & DYE CORP's petition for stay of proceedings on application filed jointly by United Light & Railways Co and American Light & Traction Co on AL&T's reorganization plan has been denied. The commission in its memorandum opinion said its decision on August 12 was predicated on the belief that proponents are entitled to be heard on the plan's merits. Allied Chemical is a large stockholder of American Light & Traction. The SEC pointed out that plan in its opinion appeared to have certain deficiencies, including absence of any assurance of expeditious compliance with the commission's 1941 divestment order. Under provisions of plan, which supersedes a previous plan, American Light & Traction would continue its existence with present capital structure as an integrated gas utility instead of being liquidated as originally proposed. The commission said that under latest plan the time within which steps are to be taken to comply with its order requiring divestment by American Light & Traction of interest in Detroit Edison Co and complete severance of United Light & Railways from American Light & Traction system is not specifically indicated and depends substantially upon completion of pipeline project and its profitable operation. (Release No. 7683).

WEST TEXAS UTILITIES Co's application for an extension of time until June 30, 1948, within which to comply with the condition of the order of December 20, 1945, that the Big Bend electric properties, excepting Presidio, be interconnected with the present electric properties of West Texas Utilities Co, has been granted. (Release No. 7687).

CENTRAL MASSACHUSETTS ELECTRIC CO, SOUTHERN BERKSHIRE POWER & ELECTRIC CO, and WACHUSETT ELECTRIC CO, all subsidiaries of the New England Electric System, have been authorized to borrow from the First National Bank of Boston. Central Massachusetts Electric Co proposes to borrow a total amount of $700,000, and, for the purpose of evidencing this indebtedness, to issue its promissory notes to be due not later than one year after date of issuance and to bear interest at the rate of 1¾ percent per annum. The declaration, filed with the commission, states that the company will require about $450.000 to pay anticipated construction costs between the present date and June 30, 1948, and $250,000 to pay a note of like amount due October 29. 1947, the proceeds of which were, in the first instance, used to pay construction costs. Southern Berkshire Power & Electric Co proposes to borrow a total amount of $200,000 and to evidence this indebtedness to issue its promissory notes to be due not later than one year after date of issuance and to bear interest at the rate of 1¾ percent per annum. The declaration stated that the proposed borrowing is, in part, for the purpose of restoring current working funds and, in part, to pay the cost of construction authorized and in progress, and anticipated construction costs to June 30, 1948. Wachusett Electric Co proposes to borrow $430,000 and to issue its promissory notes to be due not later than one year after date of issuance and to bear interest at the rate of 1½ percent per annum. (Release No. 7685, 7686 and 7688).

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NCEA Officers Elected

T. C. Wright, president of the Otter Tail Power Co, has been elected president of the North Central Electric Association. Other officers elected were E. H. Finkelnburg, vice-president of Mississippi Valley Public Service Co, vice-president, and J. A. Hennessy, Northern States Power Co, treasurer.

Washington PUD's Keep Up Efforts to Buy Utility

The 15 western Washington public utility districts whose first attempt to buy the Puget Sound Power & Light Co was declared illegal soon will set up a new non-profit corporation to accomplish the purchase.

The corporation will seek to acquire the private power company for the previous price of $135.000,000 and will then try to sell the system piecemeal to the individual districts, which will issue bonds. It will sell to each PUD only that part of the private company which lies within the district's limit.

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Gets 2 Franchises

Coolidge, Tex., has granted the Southwestern Electric Service Co a 25-year renewal of its franchise. A similar franchise has been granted by Lott. Tex.

MEETINGS

Postponed

Fluorescent Lighting Association—First Annual Cold Cathode Fluorescent Lighting Exhibit scheduled for the Commodore Hotel, New York, October 7-9, has been postponed until March, 1948.

First Announcements

Canadian Electrical Manufacturers Association—Annual Meeting, General Brock Hotel, Niagara Falls, Ont., October 9-10. R. D. Kerby, general manager, 204 Richmond St. West, Toronto 1, Canada.

National Electronics Conference—Edgewater Beach Hotel, Chicago, November 3-5. R. E. Beam, secretary, Northwestern University, Evanston, Ill.

Pennsylvania Electric Association—Communications Committee, Lord Baltimore Hotel, Baltimore, November 13-14. W. C. Feaster, chairman, South Penn Power Co., Waynesboro, Pa.

Previously Listed

Illuminating Engineering Society—Technical Conference, Roosevelt Hotel, New Orleans, September 15-19.

Indiana Electric Association—Annual Convention, French Lick Springs Hotel, French Lick, Ind., September 17-19.

International Association of Electrical Inspectors—Northwestern Section, Eugene Hotel, Eugene, Ore., September 22-24; Southwestern Section, Mission Inn, Riverside, Calif., September 29-October 1; Western Section, Mount Royal Hotel, Montreal, Canada, October 13-15; Eastern Section, Seaside Hotel, Atlantic City, October 20-22; Southern Section, George Washington Hotel, Jacksonville, Fla., October 27-29.

Edison Electric Institute—Meter and Service Committee, joint meeting with Meter and Service Methods Committee of the Association of Edison Illuminating Companies, Lord Baltimore Hotel, Baltimore, September 22-24; Purchasing and Stores Committee, Henry Grady, Hotel, Atlanta, Ga., September 29-October 1; Prime Movers Committee, Benjamin Franklin Hotel, Philadelphia, October 6-7; Electrical Equipment Committee, Benjamin Franklin Hotel, Philadelphia, October 6-7; Transmission & Distribution Committee, Benjamin Franklin Hotel, Philadelphia, October 9-10.

Association of Iron and Steel Engineers—Annual meeting, William Penn Hotel, Pittsburgh, September 22-25.

Pennsylvania Electric Association—Annual meeting, Benjamin Franklin Hotel, Philadelphia, September 23-24; Transmission & Distribution Committee, Fort Ligonier Hotel, Ligonier, Pa., October 16-17; Prime Movers Committee, Benjamin Franklin Hotel, Philadelphia, October 23-24.

American Institute of Electrical Engineers—Middle Eastern District Meeting, Biltmore Hotel, Dayton, Ohio, September 23-25; Midwest General Meeting, Congress Hotel, Chicago, November 3-7.

National Research Council—Conference on Electrical Insulation, Massachusetts Institute of Technology, Cambridge, Mass., September 24-27.

Wisconsin Utilities Association—Accounting Section, Dell View Hotel, Lake Delton, Wis., September 25-26.

Southeastern Electric Exchange—Engineering and Operation Section, Henry Grady Hotel, Atlanta, September 25-26; Sales Conference, Biltmore Hotel, Atlanta, October 29-31.

Interstate Power Club of New York—Fall Meeting, Hotel Martinque, New York, September 29.

National Farm Electrification Conference—Claypool Hotel, Indianapolis, October 7-8.

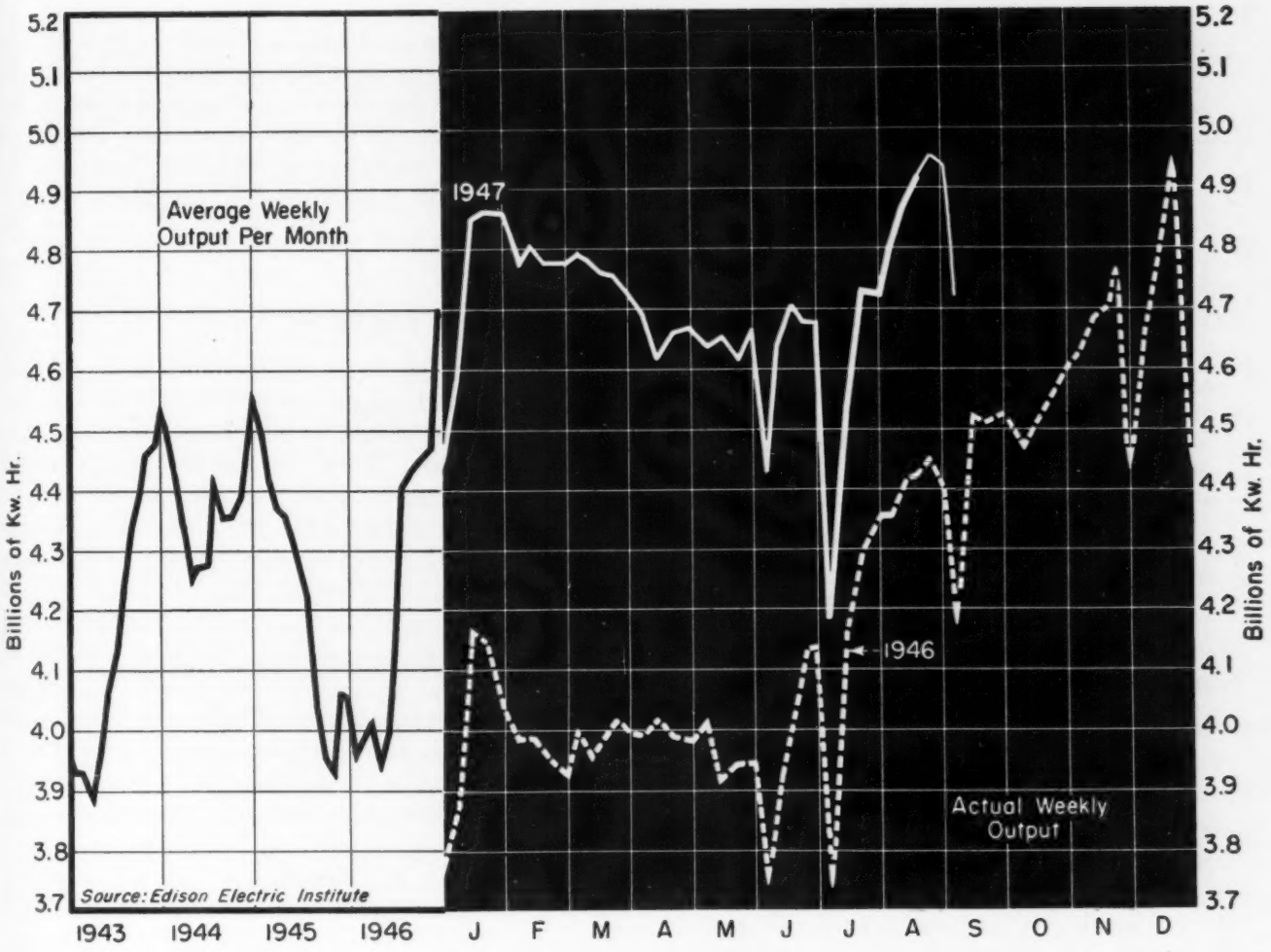
International Association of Electrical Leagues—Annual Conference, Statler Hotel, St. Louis, October 8-11.

Electrochemical Society—Fall Congress, Copley-Plaza Hotel, Boston, October 15-18.

Missouri Valley Electric Association—Accounting Conference, President Hotel, Kansas City, Mo., October 16-17; Rural Roundtable, Skirvin Hotel, Oklahoma City, Okla., October 30; Sales and Rural Conference, Skirvin Hotel, Oklahoma City, Okla., October 31-November 1.

American Standards Association—Annual Meeting, Waldorf-Astoria Hotel, New York, October 21-23.

National Electrical Manufacturers Association—Annual Meeting, Hotel Traymore, Atlantic City, October 27-31.



5 Objectives Announced by Heat Pump Committee

Five immediate objectives have been announced by the Joint AEIC-EEI Heat Pump Committee. These objectives are:

1. Assembly and analyses of test data on existing heat pump installations.

2. Coordination of present investigations of heat sources suitable for use with residential heat pumps designed for heating and cooling.

3. Coordination, compilation, and dissemination of information covering application technique.

4. Cooperation with the manufacturers in the production of heat pump equipment having acceptable operating and performance characteristics.

5. Dissemination of information of general interest on the subject and coordination of the many technical and sales activities of the heat pump.

The committee, which was organized by the Board of Directors of the Edison Electric Institute and the Association of Edison Illuminating Companies, is under the chairmanship of E. R. Ambrose, American Gas & Electric Service Corp.

Other members are E. J. Amberg, Connecticut Light & Power Co; Constantine Bary, Philadelphia Electric Co; A. C. Crandall, Indianapolis Power & Light Co; B. A. Dmitrieff, Consolidated Edison Co of New York; E. A. Freund, Union Electric Co of Missouri; W. F. Friend, Ebasco Services; G. G. Freyder, Commonwealth Edison Co; W. J. Herrman, Commonwealth & Southern Corp; Charles F. Lane, Virginia Electric & Power Co; A. D. McLay, Detroit Edison Co; William Parkerson, Middle West Service Co; O. O. Wagley, Wisconsin Electric Power Co.

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City Won't Sell Appliances

Hondo, Tex., City Council has forbidden the municipal power department to sell electrical appliances. It can sell fuses, light bulbs, and similar items. The restriction was placed when local appliance retailers complained.

Other News

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Electric Output Drops

Following the usual seasonal trend, the electric output curve moved sharply downward during the week ended September 6, 1947, which contained the Labor Day holiday. The amount of electrical energy distributed by the light and power companies of the country totaled 4,720,659,000 kwhr, comparing with 4,939,801,000 kwhr during the preceding week. During the week ended September 7, 1946, the total was 4,184,404,000 kwhr, this year's figure representing an increase of 12.8 percent.

Weekly Output, Millions Kwhr

1947		1946		1945	
Sept. 6	4,721	Sept. 7	4,184	Sept. 8	3,909
Aug. 30	4,940	Aug. 31	4,404	Sept. 1	4,137
Aug. 23	4,953	Aug. 24	4,444	Aug. 25	4,116
Aug. 16	4,923	Aug. 17	4,422	Aug. 18	3,939
Aug. 9	4,874	Aug. 10	4,412	Aug. 11	4,395
Aug. 2	4,806	Aug. 3	4,351	Aug. 4	4,432
July 26	4,730	July 27	4,352	July 28	4,435
July 19	4,372	July 20	4,293	July 21	4,385
July 12	4,531	July 13	4,156	July 14	4,295
July 5	4,190	July 6	3,741	July 7	3,978

Percent Change from Previous Year

	Sept. 6	Aug. 30	Aug. 23
New England	+ 9.5	+ 7.2	+ 5.0
Mid-Atlantic	+11.2	+10.8	+ 8.5
Central Industrial	+13.2	+13.8	+13.5
West Central	+14.4	+14.8	+15.8
Southern States	+14.0	+11.1	+10.2
Rocky Mountain	+20.1	+18.7	+15.4
Pacific Coast	+10.7	+11.5	+12.6
Total United States	+12.8	+12.2	+11.4

Electrical World
OPINION

Maybe "Sales Building" Is a Better Phrase

WHAT price load building today?

There are indications that the tight capacity situation of electric utilities will be worse before it is better. In national totals, margin between aggregate peak load and installed capacity was less than 12 percent in December, 1946. Next December that margin may shrink to the vanishing point.

This is perhaps an unnecessarily gloomy prospect. Possibly the crucial time is already past. The August heat wave sent energy outputs to record-breaking levels. The week ending August 23 saw the then highest output in the history of the industry. That record may not be greatly topped next December. This means that under the operating limitations of extremely hot weather the industry has already carried its heaviest, or mighty close to its heaviest, load of the year. Having done that successfully, the industry may have reason to discount misgivings as to its ability to handle the December load. Operating conditions will have been improved by winter temperatures, added capacity will be working, and shutdowns for maintenance will be fewer.

But whatever encouragement may be taken from the August performance, the fact still remains that many utility executives look with a very fishy eye on any thought of load building at this time. The immediate connotation of the term, "load building," is quite unhappy. No more load is wanted now, so why talk about building it. It is hard to speak in future terms of a subject that is quite unpleasing in the present tense.

The same executives will agree that the industry is going to need increased sales in the not too distant future. They will agree that markets are not created overnight, that resultful sales activities must have time for planning, organization and development, time also for the public to be impressed and to react in buying mood.

It might be a good idea to discard the phrase "load building," temporarily at least, perhaps permanently. A good substitute for it would be "sales building." The new term would avoid the unpleasant connotation the old one has at this time. There would be less objection to the thought of building sales than of building load.

Cure for Cold Feet

MEDICAL records do not tell how often lumbago results from wives' cold feet planted in the smalls of husbands' backs. Nor do statistics say how many divorces originate in the same cause. When John and Mary decide on twin beds, John's chances to get lumbago are reduced. But Mary's feet are colder still. She doesn't sleep so well. She becomes snappy and irritable. Divorce on grounds of incompatibility. All from Mary's frigid feet.

Comes now a new boon of electricity to reduce the incidence of lumbago and divorce. No more cold feet for American wives. Soon on the market will be an electric foot warmer. It is an over-sized heating pad or an undersized electric blanket; take your choice of description. It is inserted at the foot of the wife's bed, if twin, or on her side of the double bed. Great are the blessings of electricity.

Asymptotically Speaking

AS OF JUNE 30, last, the electric utilities of this country had 37,242,291 customers. Of these, an estimated 3,545,000 were connected in the less than 2 years since V-J day. In the ten years, 1931-1941, before the war, 7,117,601 customers were added. These figures say that the rate of customer increase since the war is more than twice what it was pre-war. How long will this accelerated rate continue?

One is tempted to predict a slowing-up soon. Indication of it may appear in the second half of this year.

There will come a time when rate of increase in number of utility customers will parallel closely the rate of population growth. Until then the ratio of population to customers will be a declining figure. It is now 3.81. It was 4.36 in 1940, 4.99 in 1930, and 9.77 in 1920. The decline was rapid in the 'twenties (9.77—4.99=4.78). It flattened out sharply in the 'thirties (4.99—4.36=0.63). The decline has accelerated somewhat in the elapsed six and a half years of the 'forties (4.36–3.81=0.55), but can not be called rapid by any means.

The decline in this ratio is related to the conditions of the times. It was fast in the prosperous 'twenties; very much slower in the depressed 'thirties. In comparison with the 'thirties, the 'forties so far have been boom years. If the conditions of the times were the only cause of changes in the rate of decline of the ratio, it would have

gone down much faster in the past six and a half years than actually it did. The reason the present decline is not faster is that the proportion of population from which new utility customers are drawn has now become very small.

Considering that people will continue to live in families and that there is an economic limit to the number of stores, shops, factories, offices, public buildings, and amusement places required by them, it seems that the curve of decline in the population-customer ratio must be coming pretty close to its asymptote. When the slack of the war years has been taken up, connections of new customers will drop abruptly. Maybe it would be a good bet that the figure of 2,000,000 customers added in 1946 will never be topped.

On the Way Out?

BOILING UP AGAIN is the old controversy about sales and promotional expenses included in operating costs. The Public Service Commission of New York recently granted rate increases to three gas utilities. In doing so, the Commission ordered the removal of certain appliance merchandising and servicing expenses from operating costs chargeable to rates.

The Commission found that some property classified as plant-in-service was being used for merchandising purposes. It also found that merchandising was not being charged with its proper proportion of commercial department costs.

Principal impact of the ruling is on the practices of the three companies in merchandising gas refrigerators. For these appliances, according to newspaper report, the companies "acted as distributors, dealers, installers and servicing agencies." To meet the competition of electric refrigerators, a significant part of the costs of these functions was covered into operating expenses. Thus, ultimately, they were paid out of service rates and not by the buyers of the appliances. To reverse this condition was the purpose of the commission order to the three companies.

Determination of reasonable promotional and sales expense is obviously a management responsibility. It is obvious also that such expense is a proper charge to operating costs. Increase in output resulting from promotion and selling reduces unit costs which, reflected in prices, benefits the public.

But it is conceivable that a situation may exist in which the bucking of competition is plainly a losing and a costly battle. The Commission apparently considered that a situation of this kind did exist in the present case and it acted accordingly.

Long ago the gas industry abandoned lighting as a field for its service. Should domestic refrigeration now be left similarly to the undisturbed possession of electricity?

WASHINGTON COMMENT

By R. N. LARKIN

THE war is over, but one of its most fascinating sports lingers on. That would be the practice of attempting to guess the year's kilowatthour output by the electric utility industry.

It has been formalized now, and the list of guessers includes plenty of the power business' blue chips. Bob Hatfield, of *Combustion Engineering* and once a top man in WPB's Office of War Utilities, (Equipment Production Division) has organized the guessing. There are 109 prophets, representing 34 utilities, eight manufacturers, and six consultants. There are even a couple of government men, including Cap Krug, Interior Secretary and boss of the war power job.

The sport had small, serious beginnings. Many of the guessers are ex-OWU men. They began in the days when the output was the final measure—with the peak—of OWU's very existence. One recalls a good deal of dispute during the war regarding adequacy of power supply. OWU got the ball and ran with it, much to the disgust of a number of highly placed federal officials. Had OWU ever been wrong on power supply, a lot of its people would have been working for Ickes or not working in Washington at all. Thus the interest in each year's power performance.

This year's is the second of the formal guessing. George Merritt, formerly with Westinghouse, guessed closest last year. He called the 1946 output at 223,367,000,000 kwhr. This proved to be about 1/100 of 1 percent. off. As reported in ELECTRICAL WORLD's 43rd Annual Statistical Issue last January, estimated output was 223,334,000,000 kwhr. Hatfield chose our figure because the participants didn't want to wait for EEI's actual output figure. OWU didn't want to wait either.

Of course, one such guess as Merritt's could be no more than a fluke. What tickles Hatfield so is that the average of last year's 45 guesses was less than 1 percent off the ELECTRICAL WORLD figure. This year, with 109 guessers, he's most anxious that the average be equally close. If it is, one can almost imagine Hatfield organizing his own consulting firm. He just smiles when asked if it would specialize in load forecasting.

On the assumption that no such group could miss, it is now possible to reveal that the 1947 output will be 242,231,000,000 kwhr. That's the average of all guesses. The seer closest to it is Ed Morehouse, of General Public Utilities. Ten other guessers came within 1 percent of this average, plus or minus. As might be expected, eight of them once worked for OWU. They are Ed Falck, Bill Gentry, Ralph Hinch, Bob Jeans, Bill Lyons, Don Marquis, J. E. Moore and Pat VanDeraa.

WHICH RULES—State or

Except for "national emergencies," the Taft-Hartley Act gives no special treatment to the electric power industry . . . Management and labor in this vital field are in the same basket with all others . . . This is not true of several state laws, which may take precedence over the new federal law

JOSEPH M. GAMBATESE
McGraw-Hill Washington Bureau
and
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Washington Labor Lawyer

CONGRESS last June gave the country the Taft-Hartley labor law. This act regulates to a considerable degree the relations of unions and employers engaged in any activity affecting commerce between the states.

State legislatures, meanwhile, also were alert to some shortcomings in labor-management affairs. About two-thirds of them were writing their own new laws, aimed at curbing a variety of abuses.

At least eleven state laws have specific application to electric power and other public utilities. These are the acts in Florida, Indiana, Massachusetts, Michigan, Missouri, Nebraska, New Jersey, Pennsylvania, Texas, Virginia and Wisconsin.

In dealing with public utilities, the laws in these eleven states go far beyond the Taft-Hartley law. Some go farther than others.

Texas, for instance, only bars picketing a utility when the intent is to disrupt service. The other ten provide either for government seizure or compulsory arbitration.

New Jersey, Missouri and Massachusetts permit both.

All but Texas either forbid strikes and lockouts, or delay them pending further steps.

Management's Concern

The importance of these laws to management in public utilities is evident. But they can only be significant when they apply. This raises some difficult questions.

Management must know when the company, or the union it deals with, is governed by the state law. It must know when it is subject to a provision of state law, of the Taft-Hartley law, or of both.

For example, in writing the federal law, Congress specifically granted priority on the question of compulsory union membership to state laws. These are more stringent than the Taft-Hartley law. Thus, in more than 14 states which ban all varieties of the closed shop, union shop, or maintenance of union membership, employers may not agree to any of those provisions without violating federal as well as state law. (The union shop and maintenance of membership are permitted by the Taft-Hartley law when approved by a majority of the employees affected and in states where such contracts are permissible.)

In other respects, employers in interstate commerce must abide by the federal law. They are not subject to the state law where that law conflicts with enactments of Congress. Where there is no conflict, the state law applies.

State laws regulating utility disputes, then, apply to utilities whose operations are considered "intrastate." Such utilities do not come under the Taft-Hartley law.

At the same time, these same state laws also apply to utilities engaged in "interstate" commerce where there is no conflict between the state and the federal law.

That is the big question: Do, or do not, these state laws conflict with federal law or the Constitution and thus render themselves inoperative (except on the closed shop) against "interstate" companies?

These state laws present four possible Constitutional questions:

1. Insofar as they restrict striking, do they conflict with the 13th Amendment, which forbids involuntary servitude?

2. Where they provide for compulsory arbitration, do they conflict with the due process clause in the 14th Amendment?

3. Where they restrict picketing, do they conflict with the 5th Amendment on freedom of speech and freedom of assembly?

4. Do the restrictive provisions conflict with the "supreme law clause" (Article VI, Clause 2)? In other words, do they conflict with the Taft-Hartley law, or any other U. S. law regulating labor relations?

In our opinion, the only serious question of Constitutionality arises with respect to No. 4—conflict between the state and federal laws. But let's consider the four points in order.

Involuntary Servitude

It has long been recognized that the right to strike is not a Constitutional right. Some doubt was cast upon this in the recent Petrillo case. Here, a federal district court held that since the right to quit work individually is protected by the 13th Amendment, the Lea Act, restricting the right to quit work collectively, was repugnant to this clause of the Constitution. The Supreme Court rejected this theory, however. It upheld the validity of the Lea Act as applied to Petrillo. Besides, all the state laws contain saving clauses recognizing the constitutional right of workers not to work or to quit work.

MR. REILLY, a Washington lawyer, had more to do with writing the new federal labor law than any other individual. As special counsel to the Senate Committee on Labor and Public Welfare, his advice was especially valuable to the Senate committee because of his expert knowledge and experience in the field. Mr. Reilly has served as solicitor of the U. S. Department of Labor and as a member of the National Labor Relations Board. Some of his frequent dissents as an NLRB member, particularly his opposition to the unionization of foremen, have found their way into the new law. His comments here help interpret the broad principles.

State laws regulating utility labor disputes are all based on the premise that it is in the "public interest" to prevent interruption of vital and necessary service. The Supreme Court, in recent years, has given broad latitude to the states in the matter of declaring what businesses are affected with a "public interest." Most of these cases dealt with the right of a state to regulate the rates or prices of certain companies, designated as public utilities. But there obviously is little difference between a statute fixing rates or prices and one providing compulsory action in wage disputes. upon which this opinion rested—interference with liberty of contract—has been swept away by the Parrish case, the Southern Lumber case, and the Opp case. These upheld both state and federal minimum wage legislation, contrary to earlier holdings of the court.

Picketing

If these state laws went so far as to prohibit peaceful picketing, even in intrastate industries, they would run afoul of the Supreme Court decision in American Federation of Labor vs Swing. In that case, the Supreme

Federal Labor Law?

The Wolff decision of the Supreme Court—specifically overruled—held that a Kansas statute providing compulsory arbitration of all labor disputes by an industrial relations court was contrary to the due process clause. However, the basic premise Court held that picketing is an aspect of free speech; hence could not be enjoined under state law, in the absence of violence or other unlawful conduct.

The Texas statute curbing picketing is broadly drawn. Therefore, it may be unconstitutional. It outlaws any picketing of a public utility if such picketing is intended to disrupt service or prevent maintenance, or has that effect. Presumably, then, the only kind of picketing the Texas act tolerates is picketing which does not keep workers out of the plant, i.e., unsuccessful picketing.

The other states, however, prohibit mass picketing, obstructing entrances to plants or highways, and picketing of private homes. Such statutes have been held to be within the police power of the state since they aim at preventing breaches of the peace. Hence, such statutes do not violate the 1st Amendment and are not in conflict with the National Labor Relations Act, as amended. The Supreme Court so held in Allen-Bradley vs Wisconsin Board.

Conflict with Taft-Hartley

More serious problems arise, however, in connection with the "supreme law clause." Congress, through the Wagner and the Taft-Hartley Acts, has come fairly close to preempting the whole field of labor relations. This is true insofar as the disputes these laws govern (1) affect; (2) interrupt; or (3) burden interstate commerce.

One should remember that the definition of "commerce" in the Taft-Hartley Act does not differ materially from that in the National Labor Relations (Wagner) Act.

Consequently, decisions which have upheld application of the Wagner Act to public utilities also apply to the Taft-Hartley Act. This is true even though rates of these companies are fixed by a state commission.

Thus, in NLRB vs Consolidated Edison, the Supreme Court held that a large utility which supplied corporations engaged in interstate commerce came within the jurisdiction of NLRB. It reasoned that a dispute in such a utility was bound to affect commerce. This doctrine also has been applied to traction companies. The reasoning: They furnish the primary mode of transportation for workers employed in plants producing goods for commerce.

This does not mean, of course, that every public utility affects commerce. But this much would seem true: Any power system which is the primary source of power for airports, railroad terminals, or factories with interstate

Check List of Some State Provisions Controlling Labor Relations

STATE	Ban Closed Shop	Outlaw Secondary Boycotts	Outlaw Jurisdictional Strikes	Register Unions	Regulate Utility Disputes	Curb Picketing	Strike Ballots
Alabama	X[1]			X		X	
Arizona	X						
Arkansas	X					X	
California		X	X				
Colorado	X[2]	X		X			X
Connecticut							
Delaware	X	X		X		X	X
Florida	X				X	X	
Georgia	X					X	
Idaho		X		X			
Illinois							
Indiana					X		
Iowa	X	X	X				
Kansas	X[3]	X	X	X		X	X
Massachusetts				X	X		
Michigan					X	X	X
Minnesota		X	X			X	X
Mississippi						X	
Missouri		X	X		X		X
Nebraska	X	X			X		
New Jersey					X		
North Carolina	X						
North Dakota	X	X		X		X	X
Oregon		X					X
Pennsylvania		X	X		X	X	
South Dakota	X					X	
Tennessee	X						
Texas	X	X			X	X	
Utah	X	X				X	X
Vermont							
Virginia	X				X	X	
Wisconsin	X[4]				X	X	

[1] State Supreme Court has held this law does not make closed shop unlawful.
[2] Three-fourths of employees must approve.
[3] Majority of employees must approve.
[4] Two-thirds of employees must approve.

markets is certainly not outside the scope of existing federal law.

Consider the validity of these statutes as applied to large utilities whose operation affects interstate commerce.

As to them, there is grave question about the validity of state laws which restrict the right to strike.

Strike Notices

Striking with or without notice has been held to be a concerted activity protected under Section 7 of the Wagner Act. This section is retained in the Taft-Hartley law. An employer who blacklists or fires strikers commits an unfair labor practice. To the extent that state laws restrict striking —either absolutely or except on compliance with certain conditions (waiting period, written notice, strike ballot)—it appears that they conflict with the new federal law.

So far as labor disputes are concerned, there is no Supreme Court case precisely in point. But the court has gone to great lengths in holding that any state law which affects the status of employees under the Wagner Act must yield to national law.

Thus, in Hill vs Florida, the court affirmed the right of the states to regulate mass picketing and violence in labor disputes. At the same time, the mere requirement that a labor organizer had to be licensed was found to conflict with the right—given employees under the Wagner Act—to select bargaining representative.

The federal courts have held that strikes which breach the peace in a state (eg, violence, sitdowns), or strikes which violate some federal statute, are not protected "concerted activity" under the Wagner Act. Even so, the courts have upheld NLRB decisions ordering strikers to be reinstated, even though they struck without giving notice under state law.

Presumably, therefore, the notice provisions which are characteristic of most of the state laws would be deemed in conflict with the Taft-Hartley Act. This may be particularly true insofar as failure to give such notice makes a strike enjoinable or a criminal offense, or even a matter for employer discipline.

Jurisdictional Strikes

The Michigan Law contains a provision which relates to industries generally, and is not limited to public utilities. It provides for settlement of jurisdictional disputes, without strike, by unit determinations and elections conducted by the state board. This provision is probably invalid if applied to industries affecting commerce. There is nothing in it specifically in conflict with the federal statute. But it would seem to impinge upon the exclusive power of the National Board to define the appropriate bargaining unit and certify the representative accordingly.

Bans on certain types of strikes are not invalid because there is no conflict between state and federal laws. They include:

(A) Strikes by employees not protected by the Taft-Hartley law. Among them are supervisors and public employees. Therefore, provisions of state laws which relate to strikes by employees of state or municipally owned utilities present no conflict. Such employees have no protection under the Federal Act.

The same applies to the Missouri, New Jersey, Virginia, and Massachusetts laws which restrict striking by employees in plants seized by the state government. This year's Supreme Court decision against the United Mine Workers established one thing. Employees in the seized mine facilities were government employees.

It follows, then, that employees in a utility company taken over and operated by a state government are state employees. Hence, they cannot claim a right to engage in concerted activity under the Taft-Hartley law.

(B) Strikes in breach of contract. The Wisconsin law and others like it contemplate compulsory arbitration of disputes arising under a contract. Also, they call for compulsory arbitration of an impasse reached in negotiation of a contract.

It is difficult to spell out any conflict between Taft-Hartley and the provisions of state laws which relate to strikes in violation of contract. The Supreme Court, in the Sands Manufacturing Co case, held that a strike in breach of contract was not "concerted activity" protected by the law. Therefore, NLRB had no power to order reinstatement of strikers.

(C) Strikes forbidden by the Taft-Hartley Act. The new federal law specifically makes certain kinds of strikes unfair labor practices. Examples are strikes to enforce a secondary boycott, to compel an employer to violate a certification, jurisdictional strikes, etc.

Of course, it may be argued that, since public utility strikes for certain objectives—to enforce a secondary boycott or to get rid of a foreman—are also unfair labor practices under the Taft-Hartley Act, restrictions in the state laws are valid, whenever applied to strikes of that sort.

It would seem rather difficult for this argument to succeed, however. In the Allegheny Ludlum decision, the Supreme Court indicates that where NLRB has jurisdiction over particular types of labor disputes, that field is preempted. States may not step in.

If the strike occurs, however, during the last 60 days of a contract and no notice has been given in accordance with the Taft-Hartley Act, there would seem to be no conflict. True, federal law gives NLRB authority to treat such strikes as unfair labor practices. But it also permits employers to fire persons who strike under such circumstances. Since such strikers have no rights under the federal law, the courts might well hold that they cannot complain of restrictions placed upon them by the state laws.

Lockouts

To achieve a two-sided character, most state laws also forbid utilities to engage in any lockout. Some carry criminal penalties. Other provide for revoking the utility's franchise.

We do not regard these provisions as conflicting with Taft-Hartley. Nothing in that law gives an employer a right to lock out his employees.

Check List of Provisions in State Laws Restricting Utility Strikes

State	Seizure	Compulsory Arbitration	Strike or Lockout Notice Required	Picketing Restricted	Strikes or Lockouts Barred
Wisconsin		X			X
Indiana		X			X
Pennsylvania		X			X
New Jersey	X	X	X		X
Missouri	X	X	X		X[1]
Virginia	X		X		X
Michigan		X	X		X
Massachusetts	X	X			X[2]
Texas				X	
Florida		X			X[3]
Nebraska		X[4]			X

[1] After seizure.
[2] After emergency proclamation.
[3] After appointment of conciliator by governor.
[4] By a Court of Industrial Relations.

INSULATED ALUMINUM AS A CONDUCTOR

COPPER has been the dominant electrical conductor ever since pioneering physicists found that it had nearly as good conductivity as silver. Half a century of familiarity, habit and work-technology have confirmed this position. Today there is little chance that copper will be outdistanced by another metal — unless an acute copper shortage leaves no alternative.

There has recently been just such a critical shortage of copper.

It is not surprising, then, that aluminum is being considered for uses where it previously was not the conductor of choice. These applications lie in the fields of interior wiring, in secondary services, overhead and underground cable, city networks, bare and insulated primaries and street light circuits.

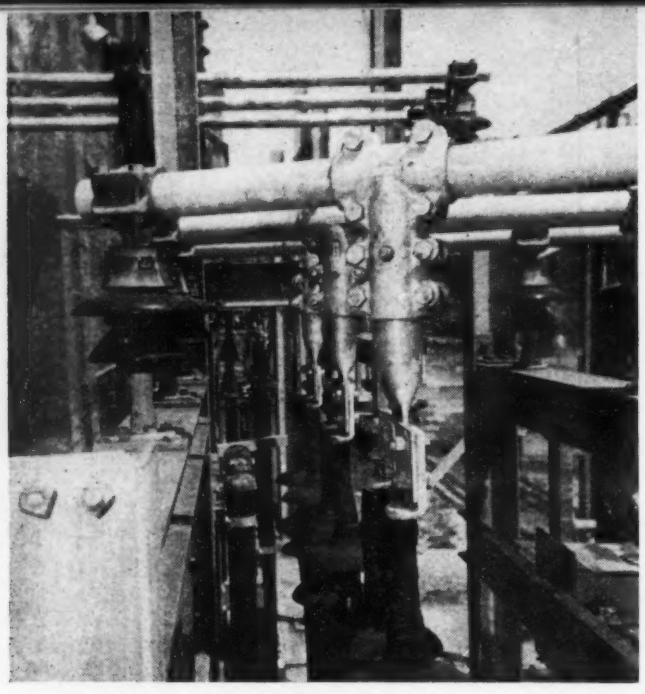
There is ample technical information about the characteristics and application of ACSR, aluminum buses, bus structures and enclosures. But there is no such library of data on aluminum in its less common uses. Before aluminum can overcome the reticence that springs from unfamiliarity, acceptance must be nurtured by a diet of reassuring information.

Engineers must learn the answers to such questions as these: What are the a-c voltage-drop properties of the larger aluminum wire? What are the connector and splicing problems? How can trouble be avoided when joining to copper? What about that oxide on the aluminum, is it a hindrance? What about the thermal factors and limitations? Will networks burn clear as quick as or quicker than copper? Are there any corona-cutting factors different from copper at primary voltage?

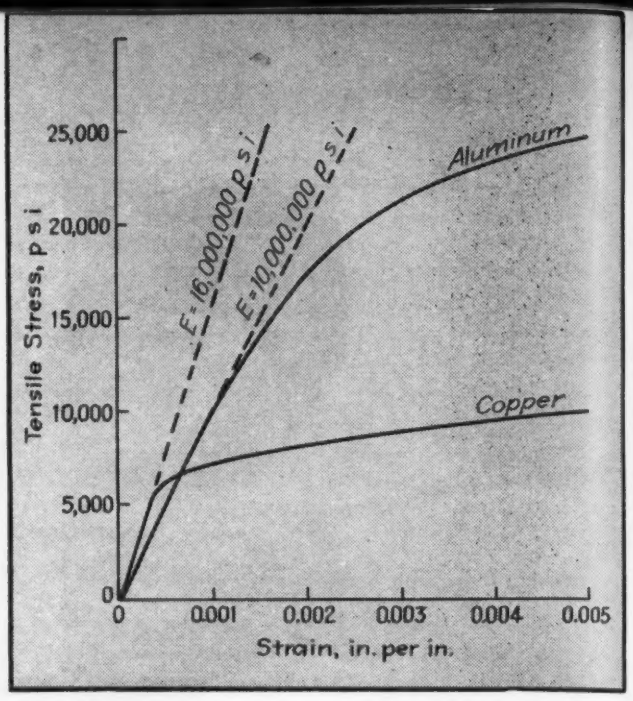
What effect is impregnation temperature likely to have on hard-drawn properties? How about adhesion of insulation and risk of damage to conductor when stripping? Is there an unsolved welding problem? Will the greater thermal expansion of insulated aluminum cable require different training in the manhole? What are reel weights? Are permissible pulling tensions different? Are normal pole heights adequate for the greater sags?

In answering these questions in the articles that follow, it is ELECTRICAL WORLD'S hope to build a better understanding of a useful conductor material.

★ A SPECIAL ENGINEERING REPORT TO THE ELECTRICAL INDUSTRY ★



15-KV CABLES (Okolite-Okoprene) with 800,000-cir mil aluminum conductors terminated outdoors with welded aluminum lugs bolted to aluminum bus in large industrial plant



STRESS-STRAIN CURVES for annealed copper vs hard-drawn E.C. grade aluminum (0.081-in. diam wire). Hard drawn aluminum gives the maximum strength compatible desired toughness

APPLICATION of INSULATED

Compilation of data and discussion of factors bearing on the use of aluminum cables and insulated overhead conductors . . . Mechanical, physical, thermal properties listed . . . Splicing, welding, soldering and connector techniques described

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FOR the past half century, the use of aluminum as a bare conductor has been universally recognized in the electrical industry. Today over one and one-half million miles of ACSR high-tension lines and numerous bus installations are in operation in this country. Economics has usually favored these applications, but only recently has it become feasible to use aluminum as an insulated conductor.

Because of conductivity differences, aluminum conductors must in general either be of larger diameter or operate at higher temperatures than copper. Where insulated conductors are concerned, larger diameters require greater volumes of insulation for the same wall thicknesses.

For similar conductor diameters, higher operating temperatures make more expensive heat-resisting insulations necessary. These factors tend to increase cost. In the past they have limited the use of insulated aluminum.

Now, however, the price differential between aluminum and copper is such that these added expenses are, in most cases, more than absorbed by the substantially lower price of aluminum.

Aluminum ore is readily available throughout the world in practically limitless quantities and no concern need be felt about shortages.

On the other hand the supply of copper seems critical or at least uncertain as against requirements, especially for the rapidly expanding use of electricity. Accordingly, some pertinent facts on insulated aluminum should be considered seriously, not as a substitute for insulated copper, but as a logical alternate that can stand on its own, economically and technically.

Chemical

Electrical conductor grade aluminum (99.45 percent) is the purest commercially used in quantity. It is always covered with an impervious oxide film which accounts for the excellent corrosion resistance of the metal. It exhibits good life outdoors including exposure near the sea coast and in addition possesses self-healing characteristics. That is, generally speaking, the longer the exposure outdoors, the slower the rate of any corrosion that may be affecting the metal.

Aluminum is anodic to copper and where used as an electrical conductor will undoubtedly, at one place or another, come in contact with copper. Under adverse conditions, in the presence of strong electrolyte, corrosion of the aluminum will take place. This fact should be recognized and precautions taken, even though service records indicate that galvanic corrosion in service is exceptional.

Thorough waterproofing of exposed aluminum to copper joints is probably the most practical preventive method which can be used. The use of a good rubber tape or waterproof, weather-resistant paint, applied with care to cover completely both metals, gives excellent results.

It has been found practical in outdoor work to use bimetallic connectors for joining the dissimilar metals,

ALUMINUM WIRE and CABLE

that is, a connector of aluminum for the aluminum conductor side with a soldered copper insert for the copper conductor. There are many aluminum-to-copper joints operating successfully under all weathering and industrial conditions including the extremely corrosive atmosphere found in electroplating plants.

Aluminum when used under rubber insulations has high resistance to corrosion due to sulphur whereas copper is easily corroded. Conversely, copper acts as a catalyst and accelerates the deterioration of rubber when in direct contact with it. Protection is accomplished by "tinning" the copper surface. However, under severely moist conditions, this is only a temporary measure as the protective metallic layer will itself eventually corrode, resulting in undesirable copper to rubber contact. Aluminum is not corroded under rubber compounds, nor will it affect, in any way, the life of rubber insulations.

Aluminum is excellent in its resistance to seacoast and industrial atmospheres, organic acids (with the exception of oxalic acid) and refinery crudes, both sweet and sour; good in nitric acids and salt water; fair in sulfuric acid and ammonium chloride solutions; and poor in hydrochloric and hydrofluoric acids and strong alkalis with the exception of the organic bases.

This metal should, therefore, operate satisfactorily in an insulated cable where it is for the most part well protected and unlikely to be attacked before the insulation itself has been destroyed.

Cable Manufacture

The manufacture of insulated wire and cable with aluminum conductors follows essentially the same pattern and uses the same equipment as does insulated wire and cable with copper conductors. No annealing is necessary since the aluminum is always used in its "as drawn" state. Concentric-, bunch-, Compack- or sector-shaped conductors may be made without difficulty.

Aluminum conductors are furnished in the hard-drawn state; copper conductors are usually annealed. Hard-drawn aluminum wire gives the maximum strength resilience, and resistance to creep or flow that is compatible with the desired flexibility and toughness. Actually, much harder wire could be made, but only at the expense of these two latter attributes. The tensile strengths as given in Table I have been found through experience successfully to combine these desirable characteristics, and are typical for E. C. (electrical conductor) grade aluminum wire.

Mechanical Properties

Since the apparent elastic limit of the aluminum is higher than of the copper, and its modulus of elasticity is lower, aluminum has greater capacity for resisting impact loads in services in which the metal must not be permanently distorted. This quality is measured by the modulus of resilience, and in the case of hard-drawn aluminum is about 6.4 times that for annealed copper. In actual practice during installation, it has been customary to permit some inelastic stretching or distortion of the copper during the pulling so that the total strain does not exceed 0.5 percent (0.005 in. per in.). On this basis, the hard-drawn aluminum could handle about twice the energy load or sudden pulling load that the annealed copper does. This is graphically represented by the respective areas under the curves at left. Since taking advantage of this would involve stressing the aluminum very close to its ultimate strength, and since pulling tensions may be difficult to control, it is suggested that the maximum pulling stress allowed for copper, namely, 10,000 psi, or about 0.008 lb per cir mil, be used when calculating the maximum pulling tensions on solid or stranded aluminum conductors. This is obviously conservative and will also be suitable for larger strands than illustrated in the curves where the "work hardening" in the wire drawing operation is less.

Aluminum conductors designed to operate at the same conductor temperature and carry the same electrical load will be larger and hence have breaking strengths akin to those of the copper cables. Further, these aluminum cables will be lighter for a given length. Since the frictional drag of a cable as it is pulled into a conduit or duct is a direct function of the cable weight, lighter aluminum cables will require lower pulling tensions. In practice, this results in an additional factor of safety during installation.

Following the same reasoning by which the maximum working stress, or pulling stress, was set at 10,000 psi, the normal working stress may be taken as 5,000 psi, or about 0.004 lb per cir mil, as is the case with copper. This would apply to cables in horizontal suspension or vertical cables hanging on their own conductors.

Due to the lighter weight and the same unit stress as allowed on annealed copper conductors, longer lengths of insulated aluminum conductor cables can be held vertically than if they were of copper.

Fatigue resulting from wind vibration has safe limits which may be derived from the endurance limit of the material, which is a measure of the maximum bending stress to which a metal can be subjected without failure for an extremely great number of times, usually 500,000,000 cycles of completely reversed stressing on an R. R. Moore type of machine. Reference to Table II shows that hard-

TABLE I
Ultimate Tensile Strength—Hard-Drawn Aluminum Wire

Nominal Wire Diameter Inch	Minimum Average Tensile Strength, lb/sq in.
0.0501–0.0600	29000
0.0601–0.0700	28500
0.0701–0.0800	28000
0.0801–0.0900	27500
0.0901–0.1000	27000
0.1001–0.1100	26000
0.1101–0.1200	25500
0.1201–0.1300	25000
0.1301–0.1400	25000
0.1401–0.1500	24500
0.1501–0.1600	24000
0.1601–0.1700	24000

drawn aluminum has an endurance limit of about 8,000 psi which is not far from the 10,000 psi for annealed copper.

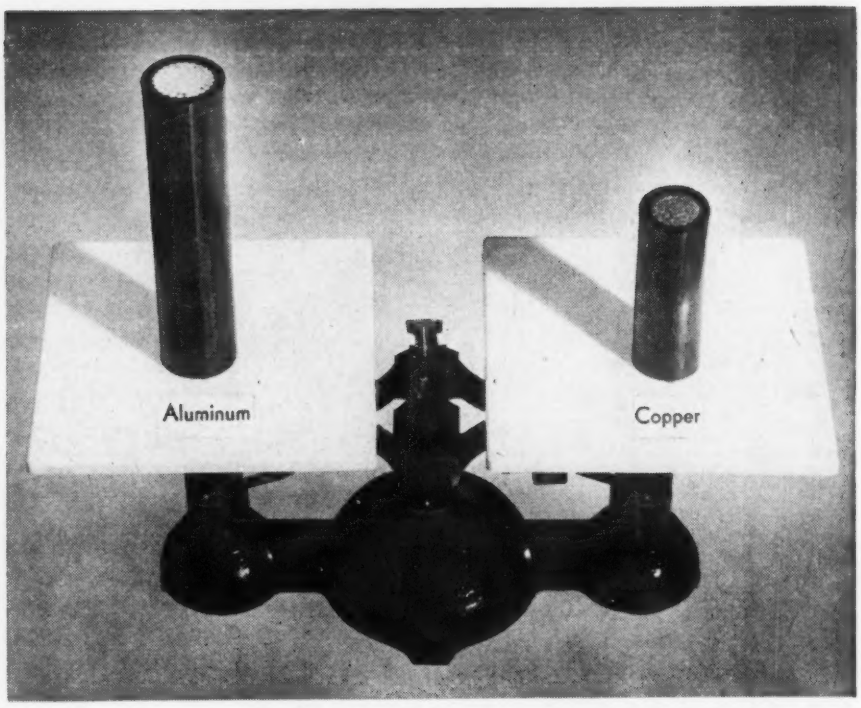
On open-wire insulated aerial lines, the insulation acts as a cushion at each supporting insulator and hence stress concentrations are reduced from those found in bare wire when rigidly supported. This cushioning should eliminate concern over "notch effect" where the wire is secured. Usually aluminum line wire is constructed with a galvanized steel core (ACSR) to obtain a high strength-weight ratio and the attendant engineering and economic advantages. One case of vertical-riser vibration was eliminated by the use of a special swivel clamp. Flared or bell-mouth clamps are also used to reduce stress concentrations induced by vibration.

In the practical application to insulated power cables which are connected to motors or generators, used in aircraft or rolling equipment such as railroad cars, or suspended on a messenger, the larger conductor cross-section usually required by the aluminum to carry the same current as the copper would result in a higher actual safe bending load (pounds) based on the endurance limit stress (psi) for the aluminum than the copper. Thus, vibration need be of no more concern with aluminum conductors than with copper in the usual power cable installations, provided the end fittings do not foster "notch fatigue," for aluminum is somewhat more sensitive in this respect than copper. Service records, however, do not disclose any reason for concern in these applications.

Use of aluminum in portable cables is obviously desirable in view of the large saving in weight which can be effected. The extreme degree of bending found in portable cable applications often exceeds the elastic limit of the material and tends to "work harden" the metal. Since aluminum is hard-drawn to begin with, it cannot absorb as much "work" as the annealed or soft copper. Nevertheless, highly successful portable aluminum conductor cables have been made, some as large as 1,500,000 cir mils with a 61x7x0.0595-in. stranding. Considerable research and development is being done on this application of aluminum.

Comparable data on the creep rate of hard-drawn E. C. grade aluminum wire versus annealed copper wire is not available in the usual temperature range for conductors. Indications are that it is somewhat higher for the aluminum than for the copper, but a long successful experience with compression type fittings on ACSR lines shows that with properly designed fittings, it is of no consequence.

A comparative summary of some pertinent mechanical properties based on 0.081-in. diameter wire which have been discussed in the foregoing paragraphs may be found in Table II.



THESE CABLES WEIGH THE SAME, carry the same current and are similarly insulated. The 700,000-cir mil aluminum cable is twice as long as its 500,000-cir mil copper equivalent

Thermal Behavior

The physical constants that influence the behavior of aluminum and copper during temperature changes are given in Table III.

Thermal expansion of aluminum becomes of interest in conduit and duct installations. Actually, the average conduit runs in industrial plants have pull boxes every 50 or 60 ft in addition to which these runs contain bends. Both the pull boxes and the bends around which the wire or cable runs have enough room to take care of this expansion, which amounts to about 0.40 in. for copper or 0.55 in. for aluminum in a 50-ft section with a 40 C temperature rise. In long duct runs "snaking" due to column action reduces cable movement at the duct

TABLE II

Mechanical Properties — Typical Wire (0.081″ dia.)

Conductor Metal	E. C. Aluminum	Copper
Condition	hard-drawn	annealed
Apparent elastic limit, psi	10,000	5,000
Yield strength, 0.5% extension	24,700	10,000
Tensile Strength, psi	27,500	35,000
Elongation, percent in 10 inches	2	35
Modulus of elasticity, psi	10,000,000	16,000,000
Endurance limit, psi	8,000	10,000

TABLE III

Physical Constants

Property	E. C. Aluminum	T. P. Copper
Density, lb/cu in, @ 20C	0.0975	0.323
Specific Gravity, @ 20C	2.705	8.94
Melting Point, deg C	657	1083
Specific Heat, cal/g/deg C	0.2259	0.0918
Latent Heat of Fusion, Btu/lb	167.4	91.0
Linear Coefficient of Expansion/deg C	23.04×10^{-6}	16.42×10^{-6}
Thermal Conductivity, cal/cm²/cm/deg C/Sec	0.52	0.923

TABLE IV
Basic Electrical Properties

Metal	E. C. Aluminum	Uncoated Annealed Copper
Resistivity, ohms per mil, foot @ 20C	17.002	10.371
Resistivity, ohms per mil, foot @ 25C	17.345	10.575
Temp Coef of Resistance from 20C, per deg C	0.00403	0.00393
Temp Coef of Resistance from 25C, per deg C	0.00395	0.00385

mouth to less than the calculated expansion. This column action is a function of flexural rigidity and surface friction. However, in view of the arbitrary distances used in practice today between the manholes, the differences in these expansions is of little consequence.

The heat storage capacity of aluminum is about 30 percent less than that of the same diameter copper conductor but is almost identical for aluminum and copper conductors with similar impedances or voltage drop as exhibited in Table VII. It follows that the temperature rise resulting from short-circuit currents will likewise be similar. This is important, as cables must be designed to carry temporary short-circuit loads without a temperature rise that would injure the insulation. On this same basis, the fusing current for aluminum conductors will be found by calculation to be in the vicinity of 85 percent of the copper currents, although with either conductor the insulation would be destroyed before the conductor fused.

Differences in the thermal conductivities will probably be noticed only when welding or soldering splices or terminations, for the heat is not dissipated along a length of aluminum as readily as along a copper conductor of the same diameter. This, however, has not been found to create a problem.

Another phenomenon of a thermal nature is "recrystallization," which results in softening of the hard-drawn wire. The lowest temperature at which this change in the crystal structure can occur is 150 C for E. C. grade aluminum, but it would proceed very slowly. Even at 250 C, it would take around 13 to 14 hours. At 300 C, however, the annealing effect is rapid and would be almost complete in not more than 20 minutes. In network systems where limiters which involve the "pressure type" of connection are used, it may be necessary to set their usual operating temperature of 265 C back to where no significant annealing effect, which is cumulative, will occur. It should be noted that the present operating level of 265 C was taken as the insulation damage temperature as evidenced by the evolution of smoke. This is a rather severe criterion for rubber-like insulations, since experience shows that destruction of the rubber hydrocarbon starts at about 200 C. A maximum transient temperature of 150 C is generally recognized as reasonable for most insulation, and its adoption for use in designing limiters would not only afford better protection to the insulation but also eliminate any question of annealing the hard-drawn aluminum conductor under fault conditions.

Soldering and welding operations anneal hard-drawn aluminum, but it is of no consequence in most instances. Manufacturing operations, including vulcanization, are generally done below 150 C, and hence, no annealing occurs. One exception is the saturation of triple-braid, weatherproof wire which is done at about 180 C and results in a reduction in the tensile strength of about 10 to 15 percent. While continuous vulcanization is done at about 195 C, the time interval is so short, a matter of seconds, that no annealing occurs. The application of a lead sheath by the hot-feed type press does not appear to cause any annealing at the "press-stops." This is due to the wall of insulation and the time interval.

Electrical conductivity of E. C.

TABLE V
Equivalent Aluminum and Copper Conductors
Basis: Similar Resistance

HARD-DRAWN ALUMINUM				TINNED ANNEALED COPPER	
	D-C Resistance, Ohms — 1000 ft			D-C Resistance, Ohms — 1000 ft	
Size AWG or MCM	Solid Wire at 25 C	Class "B" Strand at 25 C	Class "B" Strand at 75 C	Size AWG or MCM	Class "B" Strand at 75 C
16	6.72	6.85	8.20	18	8.407
14	4.22	4.31	5.16	16	5.283
12	2.66	2.71	3.25	14	3.208
10	1.67	1.70	2.04	12	2.051
9	1.33	1.35	1.62	...	.....
8	1.05	1.07	1.28	10	1.288
6	.661	.674	.807	8	.810
4	.416	.424	.508	6	.509
3	.330	.336	.403	...	.....
2	.261	.266	.319	4	.321
1	.207	.211	.253	3	.254
1/0	.164	.168	.201	2	.202
2/0	.130	.133	.159	1	.160
3/0	.103	.105	.126	1/0	.126
4/0	.0820	.0836	.101	2/0	.100
250,000		.0708	.0847	3/0	.0797
300,000		.0590	.0706	...	.....
350,000		.0506	.0605	4/0	.0626
400,000		.0442	.0530	250,000	.0535
450,000		.0393	.0471	.....	.....
500,000		.0354	.0424	300,000	.0446
550,000		.0322	.0385	350,000	.0382
600,000		.0295	.0353	.....	.....
650,000		.0272	.0326	400,000	.0332
700,000		.0253	.0303	450,000	.0295
750,000		.0236	.0283	.....	.....
800,000		.0221	.0265	500,000	.0265
900,000		.0197	.0235	550,000	.0243
1,000,000		.0177	.0212	600,000	.0223
.....		.....	.....	650,000	.0204
.....		.....	.....	700,000	.0190
.....		.....	.....	750,000	.0176
1,250,000		.0142	.0169	800,000	.0166
1,500,000		.0118	.0141	900,000	.0147
1,750,000		.0101	.0121	1,000,000	.0132
2,000,000		.00885	.0106	1,250,000	.0106

grade hard-drawn aluminum wire is not less than 61.0 percent of the International Annealed Copper Standard. The basic resistances and correction factors are presented in Table IV. The indicated temperature of zero resistance is minus 228.1 C.

Electrical Properties

The direct-current resistance of aluminum at 25 C is exactly 1.640 times that of bare annealed copper. It is about 1.59 times that of tinned or alloy coated copper. Further, the circular mil size of aluminum conductors having the same d-c resistance as a given copper conductor may be found by multiplying the copper size by these factors. Table V is arranged to show, by reading horizontally, the aluminum and copper sizes with similar direct-current resistances. To avoid complications with fittings and joints, where odd conductor sizes were obtained by using the factors, circular mils have been rounded out to the nearest standard size. Where no standard equivalent could be found, the space was left blank.

Applications requiring either aluminum or copper conductors with equal resistances are probably few, long feeders to direct-current equipment or direct-current transmission lines perhaps being the only ones. Of more importance in view of the preponderance of alternating-current systems is a comparison based on similar impedances.

The alternating-current resistance may be found by using the a-c/d-c ratios from Table VI. An aluminum conductor which has the same direct-current resistance as a given copper conductor will also have the same a-c/d-c ratio where skin effect is involved. Thus the values in column 2 of Table VI are lower than for the same circular mil size of a copper conductor.

For all practical purposes the series inductive reactance to neutral, x, may be found for aluminum conductors by the use of the standard formula for copper, namely:

$$x = 2\pi f\ (0.1404 \log_{10} s/r + 0.0153)\ 10^{-3}$$

where x = ohms reactance to neutral per 1,000 ft

f = frequency in cps

s = conductor spacing, center line to center line in in.

r = conductor radius in in.

It is common practice to increase this x term by 20 percent where single conductors are grouped in conduit with random lay and no magnetic effect is present. If a magnetic effect does exist, as is the case when installed in an iron conduit, the x term is further increased by 25 percent. Thus, with random lay in an iron conduit, the total increase in x will be 50 percent.

Phase-to-phase voltage-drop values ("long" formula) for a 1,000-ft iron conduit run on a 3-phase, 440-volt circuit with an 80 percent power factor at rated load for both copper and aluminum conductors were translated to a volt per ampere basis and arranged in Table VII on a similar voltage-drop basis, reading horizontally. As conductor size increases, the effect of resistance becomes less, and the reactance, due to larger conductor diameter, becomes less for an aluminum cable than for its equivalent copper cable based on a-c resistance. Thus, a 1,500,000-cir mil aluminum conductor will have about the same impedance as a 1,000,000-cir mil copper conductor cable.

Nominal current-carrying capacities of aluminum can be calculated using the usual formula and the a-c resistances described above. Extensive current-carrying capacity tables covering aluminum conductors are not available, but this does not present any problem when selecting the proper size conductors. Since the allowable loadings, in the National Electrical Code, may be taken at 84 percent of those for the same size copper under identical conditions, a simple multiplication will yield the current for each conductor. On this basis, Tables VIII and IX permit an easy comparison under two typical conditions. Actually the relationship will, in general, be the same under all conditions of installation. Due to the universal practice of selecting copper conductor sizes from the standard current-carrying capacity tables on the basis of the next larger size rather than the nearest, it often results in an economy if the aluminum conductor is chosen for the actual load. Use of standard conductor sizes for the equivalents leads to some differences in current-carrying capacity.

Reference to these current-carrying capacity tables will disclose the fact that the aluminum equivalents on this basis are the smallest of the three equivalent methods discussed. This is due to the larger diameter, and hence greater radiating surface, of the aluminum cable with a-c resistance equal to a given copper cable. A balance between resistance and radiation results in these conductor sizes. In circuits involving short runs of low-voltage power cables, and in high-voltage installations, the current-carrying capacity will be the dominant factor in determining the correct conductor. It is on this basis, obviously, that aluminum shows up to the best economic advantage.

There is still another way of approaching the question of current-carrying capacity, namely, through the use of a higher temperature insulation. It so happens that 84 percent of the current-carrying capacity for a given conductor size with a 75 C in-

TABLE VI

A-C/D-C Resistance Ratio for Aluminum at 60 cycles

(1) Aluminum Cdr. Size AWG or MCM	(2) In Air or Non-Metallic Conduit	(3) With Metallic Sheath or Metallic Conduit
Up to 2/0	1.000	1.000
3/0	1.000	1.003
4/0	1.001	1.010
250	1.002	1.013
300	1.003	1.02
350	1.003	1.03
400	1.004	1.04
500	1.006	1.06
600	1.009	1.08
700	1.012	1.11
750	1.013	1.12
800	1.015	1.13
1000	1.023	1.19
1250	1.036	1.26
1500	1.052	1.35
1750	1.070	1.44
2000	1.089	1.54

To determine effective 60-cycle A-C resistance, multiply the D-C resistance values after correcting for proper temperature, by the A-C/D-C resistance ratio given above. These apply to the following specific conditions:

Use Column 2 for:

(a) Single conductor non-metallic sheathed cables, in air or non-metallic conduit.

(b) Single conductor metallic sheathed cables with sheaths insulated, in air or separate non-metallic conduits.

(c) Multiple conductor non-metallic sheathed cables, in air or non-metallic conduit.

Note: Column 2 includes skin effect only. For close spacing such as multi-conductor cables or several cables in the same non-metallic conduit, there will be an additional apparent resistance due to proximity loss. This varies with spacing (insulation thickness) but for most purposes can be neglected without serious error in these cases.

Use Column 3 for:

(a) Multiple conductor metallic sheathed cable.

(b) Multiple conductor non-metallic sheathed cables in metal conduit.

(c) Two or more single conductor non-metallic sheathed cables in same metallic conduit.

Note: The above factors are based on a 75 C conductor temperature.

The factors in Column 3 include skin effect, proximity effect and all other A-C inductive losses.

ALUMINUM CONNECTOR and aluminum conductor permanently bonded together by arc-welding

TABLE VII

Equivalent Aluminum and Copper Conductors Basis: Similar Voltage Drop, 3-1 Cdrs. in Magnetic Conduit, 80% P.F., 3-Phase, 75C Cdr. Temperature

COPPER CONDUCTOR		ALUMINUM CONDUCTOR	
Size AWG or MCM	VoltsDrop phase-to-phase per Amp per 1000 ft	Size AWG or MCM	Volt Drop phase-to-phase per Amp per 1000 ft
14	4.67	12	4.75
12	3.00	10	3.02
10	1.86	8	1.90
8	1.21	6	1.21
6	.793	4	.790
4	.514	2	.509
2	.341	1/0	.336
1	.281	2/0	.275
1/0	.232	3/0	.228
2/0	.193	4/0	.190
3/0	.163	250	.169
....	....	300	.148
4/0	.138	350	.134
250	.126	400	.124
300	.113	....	....
350	.104	500	.108
400	.097	600	.098
....	....	700	.091
500	.088	750	.089
....	....	800	.086
600	.082	900	.082
700	.076	1000	.080
750	.075	....	....
800	.073	1250	.073
900	.070	....	....
1000	.070	1500	.069
1250	.067	1750	.067
1500	.065	2000	.065

sulation (RH) is approximately equal to that for the same size conductor with a 60 C insulation (R). Where the voltage drop is not a factor, aluminum conductors with a 75 C insulation can then be substituted size for size with the copper having a 60 C insulation. This feature is particularly convenient, especially where availability is important, and where duct areas and space are limited.

Short circuits have been mentioned before. Allowing an 80 C conductor temperature rise during a 15-cycle short circuit, the currents given in Table X can be safely handled. If the equivalent aluminum and copper sizes based on voltage drop are compared, they will be found to be reasonably close.

Splicing and Terminating

Aluminum may be safely and permanently installed without apprehension provided connections and splices are properly made. Procedures used are no more difficult than with copper after experience has been gained.

Difficulties encountered in splicing and terminating were due primarily to the inherent oxide film which forms rapidly on all aluminum surfaces when exposed to the air. This oxide film is an insulator which must be broken through or removed in order to form good low-resistance connections. Further, air must be excluded by tight metal-to-metal contact and by the use of a good joint compound similar to No-Ox-Id A-Special or ALCOA No. 1 Joint Compound.

When connecting aluminum with fittings of dissimilar metals such as copper or bronze, the fittings should be plated with a heavy coating of zinc or cadmium or tin to avoid possible trouble from electrolytic corrosion. Aluminum is definitely anodic to copper and in the presence of an electrolyte, a tendency toward galvanic action is present. Plating fittings with zinc, cadmium or tin reduces dissimilarity and minimizes the objectionable condition. In exposed locations, junctions should be well covered with rubber tape to insure permanently satisfactory operation. This does not differ from best procedures in exposed copper-to-copper connections.

There are several good methods of joining insulated aluminum cable. While some of these may appear impractical because special equipment is involved, they are presented here completely to cover the methods available. These are as follows:

1. Welding
2. Soldering
3. Compression
4. Bolting

Welding: Welding has been used successfully for many years. Welds can be made with inert-gas-(argon) shielded electric welding equipment or the oxy-acetylene torch. The former method is probably superior in that it does not require the use of any flux.

The Aluminum Co of America has in recent years used alternating-current, argon-shielded welding with high-frequency arc stabilization. Excellent results have been obtained with a 300-amp Miller Arc Welder utilizing a Linde Air Products Co water-cooled torch.

In making welds on insulated cable, care must be taken to prevent damage to insulation caused by excessive heat. A heat dissipator has been successfully used in this respect. This consists of a heavy copper or aluminum plate bored and split to fit closely on the conductor between the weld and the insulation. The halves of the plate are held tightly together on the cable during welding by flat iron bands or bolts.

Lugs and connectors should be made of E. C. grade aluminum. The lug body should be open on both ends

so that when slipped in position on the cable, a cup is formed on the upper end to permit puddling.

In welding to the lug, the strand ends are first fused together, then bonded to the sides of the lug. The cavity is then filled using 2S or E. C. aluminum wire.

In making a splice, the conductor ends should be cut at an angle, keeping the angles face up to permit a "V" weld. A split aluminum sleeve is slipped on and procedure similar to that for lugs is followed.

The oxy-acetylene flame can also be ultilized for welding, this in conjunction with a flux similar to ALCOA No. 22. However, extreme care must be taken ultimately to remove all traces of the flux so as to avoid corrosion.

Soldering: Entirely satisfactory soldered connections can be made between or to aluminum using methods not too different from those normally employed in joining copper.

To "tin" aluminum successfully for good soldering, it is first necessary completely to destroy the tough surface oxide film. This can be accomplished by either abrading the surface under molten solder or by using a proper flux, then soldering.

Solders for the former method are usually high in zinc content and alloy readily with aluminum. They are of fairly high softening point, being completely fluid at around 350 C (662 F). The aluminum is prepared for soldering by thoroughly wire brushing. It is then heated to the required temperature with a torch. The solder, in the form of a stick, is rubbed firmly into the surface, destroying the oxide under the melting alloy and allowing "tinning" to take place. After this, standard procedures may be followed.

This method proves practical and gives excellent results where surfaces to be soldered are completely exposed. It is not practical where multi-strand cables are involved and each strand would have to be individually "tinned."

For general work, it is best to use a proper solder and flux whose application approaches more closely accepted methods.

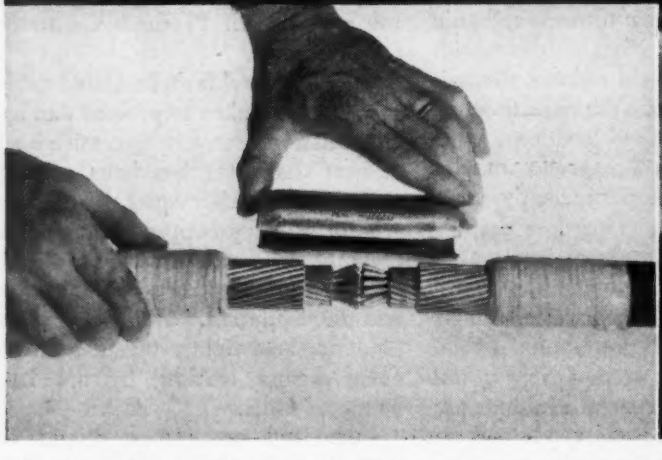
Corrosive fluxes containing zinc chloride are not recommended since it is difficult completely to remove residues. Standard lead-tin solders are likewise not recommended since they do not alloy readily with aluminum, and are more susceptable to galvanic corrosion.

ALCOA No. 62 flux and XA-803 solder have been found to give very satisfactory results. The No. 62 flux is a non-corrosive material suitable for use only with solders that have good flow characteristics below 500 F.

TABLE VIII
Equivalent Sizes and Current Loadings
Basis: Single Conductor in Air at 40 C, Ambient, 0-5000 Volts

COPPER CONDUCTOR			ALUMINUM CONDUCTOR		
Size	Maximum Load — Amperes		Size	Maximum Load — Amperes	
AWG or MCM	Rubber Ins., 75C	V. C. Ins., 85C	AWG or MCM	Rubber Ins., 75C	V. C. Ins., 85C
14	26	32	12	28	37
12	33	44	10	37	47
10	44	56	8	51	63
8	61	75	6	70	82
6	83	98	4	92	109
....	....	....	3	107	124
4	110	130	2	126	145
3	127	148	....	....	....
2	150	173	1	144	169
1	172	201	1/0	170	196
1/0	202	234	2/0	197	226
2/0	235	269	3/0	229	260
3/0	273	310	4/0	264	296
....	....	....	250	296	333
4/0	315	352	300	330	371
250	352	396	350	372	409
300	393	442	400	404	443
350	443	487	500	459	510
400	481	527	600	511	569
500	546	607	700	559	625
....	....	....	750	580	652
600	608	678	800	602	673
....	....	....	900	644	727
700	665	745	....	....	....
750	691	776	1000	692	770
800	717	808	....	....	....
900	767	865	1250	787	878
1000	824	918	1500	867	976
1250	938	1045	1750	950	1072
1500	1032	1162	2000	1022	1170

FOUR STEPS IN MAKING A SOLDERED SPLICE IN ALUMINUM CABLE



1 Preparation: Outler layers of strands are stepped and central wires fanned out to permit easy flow of flux

2 Preheating: Proper temperature is reached when the XA-803 solder stick starts to melt when placed on the conductor

TABLE IX
Equivalent Sizes and Current Loadings
Basis: 3-Single Conductors in Iron Conduit at 30 C Ambient, 0-5000 Volts

COPPER CONDUCTOR			ALUMINUM CONDUCTOR		
Size	Maximum Load — Amperes		Size	Maximum Load — Amperes	
AWG or MCM	Rubber Ins., 75C	V. C. Ins., 85C	AWG or MCM	Rubber Ins., 75C	V. C. Ins., 85C
14	15	25	12	17	25
12	20	30	10	25	34
10	30	40	8	38	42
8	45	50	6	55	59
6	65	70	4	71	76
...	...	...	3	84	88
4	85	90	2	97	101
3	100	105	...	...	...
2	115	120	1	109	118
1	130	140	1/0	126	130
1/0	150	155	2/0	147	155
2/0	175	185	3/0	168	176
3/0	200	210	4/0	193	197
...	...	...	250	214	227
4/0	230	235	300	240	252
250	255	270	350	260	273
300	285	300	400	282	302
350	310	325	500	319	340
400	335	360	600	353	382
500	380	405	700	387	412
...	...	...	750	399	420
600	420	455	800	412	433
...	...	...	900	437	466
700	460	490	...	...	...
750	475	500	1000	458	491

Temperatures in excess of 500 F cause rapid deterioation of the flux with the formation of a brown or gray film which prevents smooth flow and adhesion of the solder. For temperatures up to 500 F, the flux has sufficient activity for most soldering jobs.

XA-803 solder has all the flow characteristics necessary for soldering with No. 62 flux. It approaches aluminum more closely in the electromotive series than standard lead-tin solders and alloys readily with that metal.

The secret of good soldering lies in proper fluxing. If a joint is fluxed at between 400 F and 500 F and care is taken not to decompose the flux, standard soldering procedures may subsequently be followed.

Soldered Splices

In small conductors, pig-tails or Western Union style splices may be easily soldered. The aluminum should be preheated with an iron or torch and then fluxed. Subsequent operations are no different from accepted soldering practices.

The following procedures has been used successfully in making soldered splices on stranded conductors.

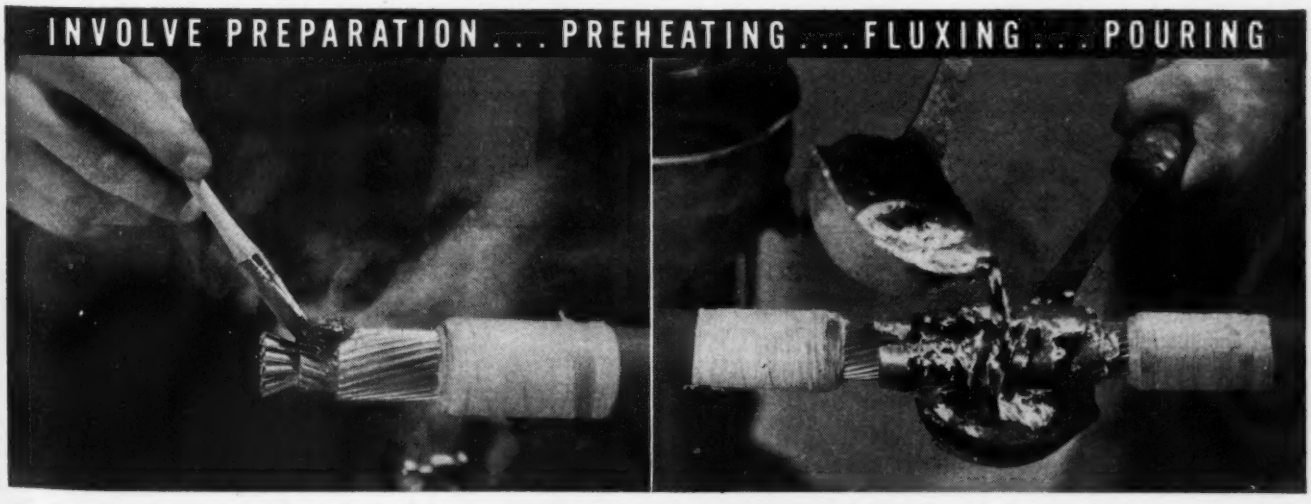
1. The cable ends to be joined are cut perpendicular to the cable axis, the insulation is removed, and asbestos wraps applied in accordance with normal procedure, care being taken not to nick the strands while removing the insulation.

2. The two outer layers of strands are stepped back, the maximum step on the outerlayer being equivalent to about one-quarter of the length of the split connector sleeve to be used. The remaining strands are fanned out. Stepping requires little time and may be accomplished satisfactorily with a small tube or pipe cutting tool. The advantage of stepping lies in the fact that it allows deeper, more uniform penetration of flux and solder. Where stepping is found impractical, the spaces between the ends of the strands which are closed by burrs from sawing should be opened with a sharp pointed tool. Exposed surfaces should be cleaned and wire brushed.

3. The conductor is heated *slowly* with a torch to insure uniform heat penetration throughout each layer of strands. The proper temperature is that at which an XA-803 solder stick will just melt when brought in contact with strand surfaces. Higher temperatures should be avoided in order not to damage the flux.

4. No. 62 flux is applied over the strands with a brush, working the flux into all interstices and the ends of the cable. To facilitate flow, the flux may be thinned with about 25 percent by volume of ethyl or methyl alcohol, or it may be heated slightly.

5. The split connector sleeve (tinned copper) is placed in position. It should fit loosely to allow solder to flow freely around strands and



3 Fluxing: The No. 62 flux is applied over the strands with a brush working the flux into all interstices and over the ends

4 Pouring: When the strands are properly "tinned" the assembly is tightened and the XA-803 solder is ladled into the splice

through interstices. Abolt 1/8-in. space is allowed between conductor ends.

6. Solder is ladled at a pot temperature of from 550 F to 600 F into the connecting sleeve and allowed to flow freely to tin the conductors. (This temperature range is apparently higher than the recommended 500 F maximum for efficient fluxing. However, allowance has to be made for temperature drop caused by ladling and by solder contact with conductor strands, especially in large cables.) When the conductors are tinned, and while the solder is still fluid, the ends are pushed tightly together and the connector is closed with pliers.

7. Ladling is continued and the splice finished per standard procedure.

Soldered Terminals

The application of lugs is a standard operation provided that the fluxing procedure and soldering temperatures described above are closely followed. Copper lugs tinned with XA-803 solder should be used. Stepping back of strands is not necessary.

Where cable ends are free, the following method of applying terminals may be used to advantage:

1. The cable end to which the lug is to be applied is cut perpendicular to the cable axis, the insulation is removed and asbestos wraps applied in accordance with normal procedure, care being taken not to nick the strands while removing the insulation.

2. The interstices which are closed by burrs should be opened with a sharp pointed tool. Ends and exposed surfaces should be cleaned and wire brushed.

3. Strands are heated for from 15 to 30 sec, depending on conductor size, by dipping into a solder pot between 550 F and 600 F. On removing, excess solder is shaken off to leave the surfaces clean for fluxing.

4. The conductor is dipped into a small container of flux and allowed to remain until boiling stops. The flux may be thinned with about 25 percent by volume of ethyl or methyl alcohol to facilitate flow, or it may be heated slightly. Fresh flux should be used for each termination.

5. Excess flux is shaken from the conductor and it is immediately immersed in the solder to tin the strands.

6. The lug is tinned and filled with molten solder.

TABLE X
Short Circuit Currents

Condr. Size	CM	Current for 80C Rise in 15 Cyc
	ALUMINUM CONDUCTOR	
4	41740	3100
2/0	133100	9800
3/0	167800	12400
700	700000	52000
750	750000	55000
	COPPER CONDUCTOR	
6	26250	2900
1/0	105500	12000
...	.....	.....
500	500000	55000
...	.....	.....

7. The conductor end is slipped into the lug and held till solder sets.

Copper to aluminum splices may be made without difficulty. The XA-803 solder and No. 62 flux serve equally well for both metals.

The durability of soldered aluminum joints has been demonstrated. In one case, an aluminum cable was installed with soldered splices in 1909 by the Chicago Surface Lines, Chicago, Ill. This was a 1,630,000-cir mil stranded-aluminum, paper-insulated, lead-sheathed cable. In 1945, after 36 years of service, the connections were unsoldered and found to be in perfect condition. They were resoldered and placed back in service.

Compression: Compression type fittings have been widely used for over 30 years, primarily on ACSR aerial lines. More recently, they have been adopted by the aircraft industry for wiring in sizes up through No. 4/0 AWG. They are applied to the conductor by means of a die, usually hydraulically actuated.

Cross-sections through the compressed areas of joints made by this method show the strands and fitting bodies to be compacted into practically a solid mass. The wiping action of one metal surface against another during the deformation breaks through the aluminum oxide film, giving low electrical resistance. It is necessary to use a good oxidation-inhibiting compound in joints of this type to prevent reformation of the oxide with subsequent high resistances.

These compounds should be forced well up into the strands and should completely coat all surfaces before connections are made. Several manufacturers supply their fittings with inhibiters sealed in the barrel. When the fittings are worked on before compressing, the compound is forced up into and around the strands.

ALCOA No. 1 Joint Compound is an excellent material for this application. It has a continued dissolving action on the aluminum oxide film without attacking the aluminum. However, it is water soluble and if used, should be well protected by a thoroughly waterproof taping job.

Compression fittings should be made of E. C. grade aluminum for best results. The use of the same metal here eliminates difficulties which may arise from different coefficients of expansion and different rates of recovery after compression. The use of copper and the alloys of copper is undesirable since this metal and its alloys have lower coefficients of expansion than aluminum, which causes the conductor to creep and the joint to loosen under continued load cycling. It has a greater recovery rate after compression than aluminum, which leads to looseness and high resistances. Tests have shown that continued usage under these conditions results in internal oxidation and subsequent failure.

Bolted Connections: Bolted fitting designs are numerous but the majority of these will not operate successfully on aluminum. In selecting bolted fittings, the advice of a reliable manufacturer should be followed.

Generally, for successful operation, a fitting of this type must have high contact pressure, and large contact area. Pressures should be transmitted to the conductor through the medium of a large pressure bar or area. Set screw connections are definitely poor. The connector bodies and bolts should be rugged enough to exert considerable pressures.

TABLE XI
Branch Circuit Wire Details

Size AWG*	Diam in.	Weight lb/1,000 ft	Amp**
	ALUMINUM TYPE RU		
12	.15	12	17
10	.17	17	25
8	.21	26	34
6	.29	46	46
	COPPER, TYPE R		
14	.16	21	15
12	.18	28	20
10	.22	49	30
8	.28	80	40

* All sizes are solid with the exception of No. 6 AWG which is stranded.
** Maximum allowable current with three wires in conduit with a 30 degree C ambient.

Internal serrations are not recommended unless sufficient pressure can be exerted to bury these completely in the aluminum strands. If the conductor is allowed to ride on the knife edges of the serrations, contact area will be reduced considerably with resulting high-resistance joints.

Two types of connectors which have given excellent results under cyclic loading at full rated load, "in air," are well worth mentioning here. The first, a heavy duty Burndy "NA-C," is a four-bolt, tin-plated, copper-alloy assembly. It has exceptionally large contact area and is capable of exerting extreme pressure through the medium of its four bolts. The operating temperature of this lug is well below conductor temperature. The second, a Thomas and Betts "Tite-Bind," is a conical wedge type of cadmium-plated copper alloy. The contacting surface of the cone is serrated and sufficient pressure is generated to drive these serrations into the aluminum. Excellent electrical contact is obtained in this manner.

Certain precautions are recommended for all connectors. Since they are usually of copper or copper alloy, they must be coated with zinc, cadmium or tin. The coatings should be sufficiently thick to afford adequate protection. An antioxide paste should always be applied before installing connectors. Various compounds are available and can be obtained from connector manufacturers; also, other compounds such as No-Ox-Id Grade A Special," manufactured by the Dearborn Chemical Co, and ALCOA "No. 1 Joint Compound" are satisfactory. As mentioned previously, however, the No. 1 Joint Compound is water soluble, and care should be taken to prevent its washing away.

Cable Constructions

For almost every type of service, insulated aluminum wires and cables may be used in place of the usual copper constructions. Aluminum offers an advantage over copper in many instances where weight considerations are important. This, coupled with an economic advantage and availability, makes aluminum a conductor material which warrants consideration. The use of aluminum conductors involves no changes in the accepted standards for insulated wire and cable. It is conceivable, however, that due to the lighter weight of an aluminum conductor, there will be less likelihood of mechanical damage during handling.

TABLE XII
600-V Power Cable Details

AWG or MCM Size	Diam in.	Net Wgt.*	Shipping Weight
	ALUMINUM		
2/0	.70	262	470
350	1.03	591	1020
500	1.16	776	1355
700	1.34	1046	1625
	COPPER		
1/0	.66	451	660
250	.92	1004	1370
350	1.03	1344	1775
500	1.08	1516	1945

* The weights are given in lb per 1000 feet. The insulation is Okolite-Okoprene, standard wall thicknesses.

Rubber-insulated aluminum building wire is now being manufactured in accordance with the standards of the Underwriters' Laboratories, Inc, and is fully approved. For branch circuits, the RU-type, small-diameter, rubber-latex-insulated, braid-covered wire can be used with no need for larger conduit than that required for Type R with the same carrying capacity. The particulars are summarized in Table XI.

As previously discussed, Type RH aluminum can be substituted for Type R copper, size for size. The physical dimensions are the same as shown for Type R in Table XI and the current loadings are those given in Tables VIII and IX.

Rubber-insulated aluminum power cables are being used for all purposes in major industrial plants, including large feeders, and motor and generator leads. Plant engineers have found that it is not always necessary to use larger conduits to accommodate aluminum conductors, due to the range of conductor sizes each conduit is allowed to contain, as specified in the National Electrical Code. Furthermore, the saving in cable cost in the large circular mil sizes offsets additional costs of larger conduits.

High-voltage operation does not present any difficulties as far as insulated aluminum is concerned. An apparent advantage from lower electrical stresses at the conductor surface due to a larger diameter conductor is insignificant.

An idea of the physical differences in power cable sizes can be obtained from Table XII.

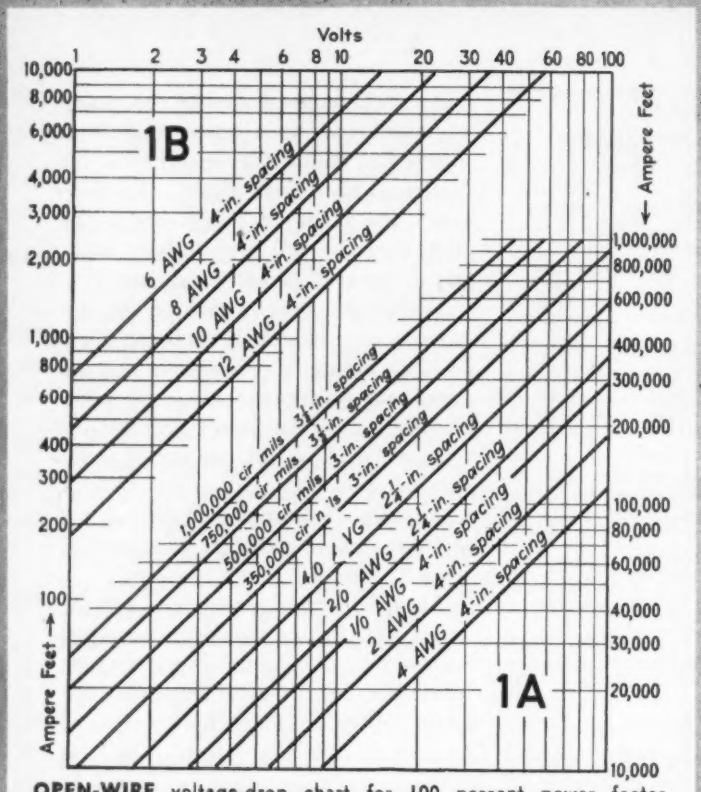
Aluminum conductors are ideal for aerial circuits or cables in vertical suspension, due to the large savings which can usually be effected through taking advantage of the light weight of the metal. An illustration of this on aerial installations may be found in Table XIII, which covers 3-conductor, 600-volt, Okolite-Okoprene self-supporting cable. Not only does aluminum cable permit a lower cost installation than with copper, but the superior voltage regulation justifies it even over an open-wire, low-voltage, secondary. Using the same messenger as normally furnished for the same size copper conductor will permit either longer spans or less sag.

It is possible to use unsupported aluminum as the conductor in weather-proof types of wire. However, because of the lower tensile strength of aluminum, 24,000 psi compared with 62,000 psi for hard-drawn bare copper, No. 6 AWG, it is necessary to use greater sags with consequent greater spacing between wires, or shorter spans. This involves the use of either higher poles or an increased number of poles.

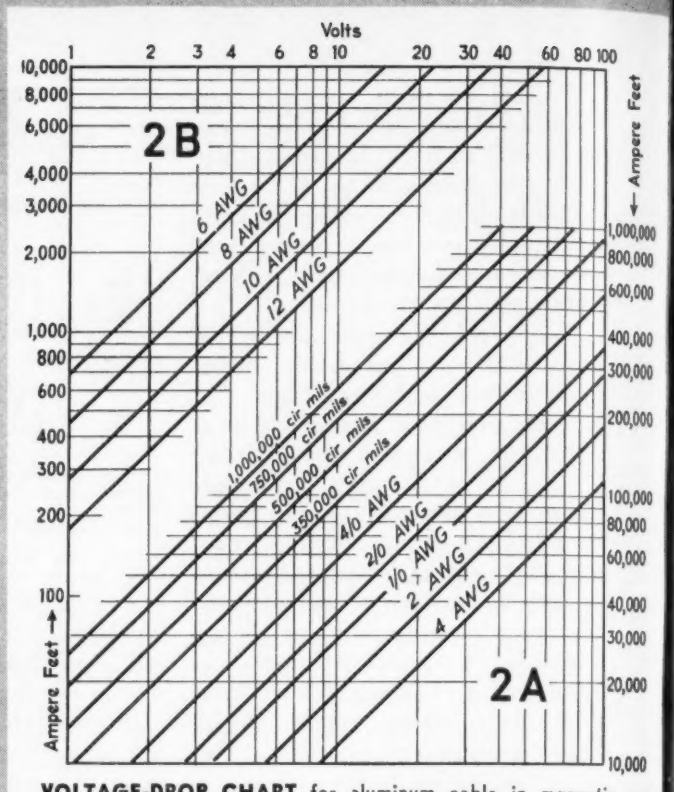
TABLE XIII
600-V Self-Supporting Aerial Cable Particulars
Basis: Similar Impedances

ALUMINUM CONDUCTOR					COPPER CONDUCTOR				
Size AWG or MCM	Max Load Amp	Imp. to N. ohms	Messenger Size	Total Weight Lb	Size AWG or MCM	Max Load Amp	Imp. to N. ohms	Messenger Size, in.	Total Weight Lb
350	324	.068	3/6	2261	4/0	278	.070	3/8	3007
500	400	.052	3/8"	2958	300	358	.055	1/2	4336
600	443	.046	7/16"	3673	400	440	.045	9/16	5539
750	504	.041	1/2"	4399	500	500	.040	9/16	6618

NOTE: The impedance and weight figures are for 1000 feet of Okolite-Okoprene cable. The messengers are all 30 percent conductivity, extra high strength Copperweld, and are designed for 1½ percent maximum sag in 125-foot spans at 60 F.



OPEN-WIRE voltage-drop chart for 100 percent power factor loads; three single conductors, flat spacing at 75 C temperature. (a) Sizes 1,000,000 cir mils to No. 4 at labeled spacing; (b) No. 6 to No. 12 at 4-in. spacing. 440-v, line-to-line, 3-phase, 60 cycles



VOLTAGE-DROP CHART for aluminum cable in *magnetic* conduit; 100 percent power factor loads, three single conductors at 75 C temperature. (a) Sizes 1,000,000 cir mils to No. 4; (b) No. 6 to No. 12. Circuit: 440-v, line-to-line, 3-phase, 60 cycles

VOLTAGE-DROP CHARTS for Selecting

F. A. GUNTHER
Aluminum Company of America
Pittsburgh, Pa.

IN THE DESIGN of power and lighting distribution systems, voltage drop is generally the determining factor in selecting wire sizes. This is particularly true for large industrial plants. Much time and effort is spent in making accurate mathematical computations for voltage drop. Charts are the most convenient and practical way of making these studies. Catalogs, handbooks, and papers contain charts and other voltage-drop information for copper cables open in air, in non-magnetic conduit, and in magnetic conduit. Some of these charts require additional calculations to obtain voltage drops to neutral or phase-to-phase; others are so condensed that errors are made in using them. The desire for speed and accuracy led to the development of the charts presented in this article. They provide much needed information on voltage drop for insulated aluminum cable now being used in quantity for power and lighting distribution work.

Voltage-Drop Calculations

These charts were plotted from calculations using the following formulas:

$$(1)\quad V_{dn} = V_s - V_1$$

$$(2)\quad V_s = \sqrt{(V_1 \operatorname{Cos} \theta + RI)^2 + (V_1 \sin \theta - XI)^2}$$

$$(3)\quad V_d = \sqrt{3} \times V_{dn}$$

Where X = Reactance of cable to neutral
R = Resistance, corrected for temperature
I = Load current
V_1 = Volts to neutral at load
V_s = Sending volts to neutral
V_{dn} = Volts drop to neutral
V_d = Volts drop phase to phase for 3 phase

In formulas (1) and (2) reactances are to neutral, and the results are also to neutral. Volts drop for single phase are obtained by multiplying the chart values by 1.155.

Resistance values are corrected for temperature and skin effect, but proximity effect is customarily neglected. The maximum conductor temperature of 75 C was used in calculations for the accompanying set of charts. Where higher temperature insulations are used and the cable is worked to a maximum, a similar set of charts can be made on the basis of the higher resistance at the maximum allowable temperature, such as 85 C for varnished cambric. Resistance values for aluminum cable are based on commercial standards for hard drawn aluminum wire with conductivity 61 percent of the International Annealed Copper Standard, corrected for stranding, skin effect, and temperature. Resistance at 75 C for the more commonly used sizes of aluminum insulated cable is shown in Table 1.

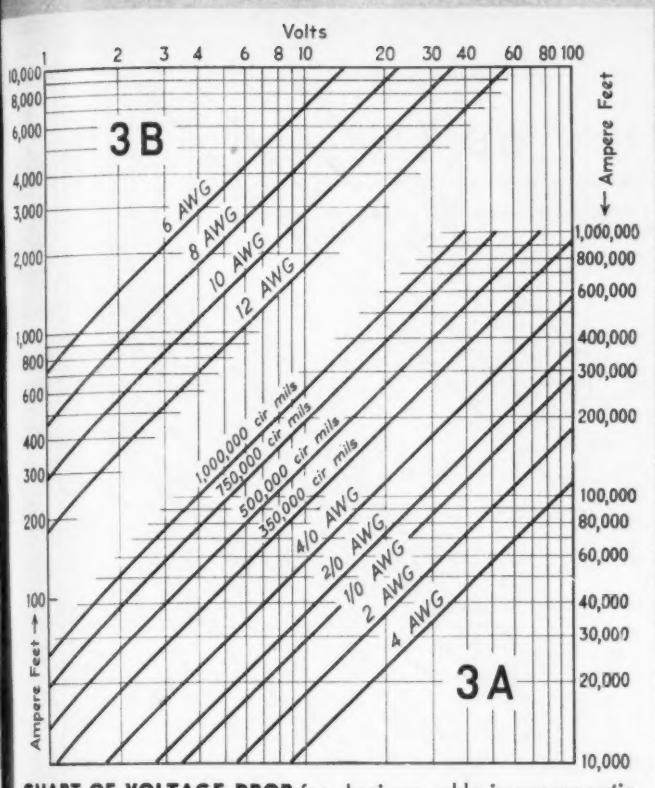
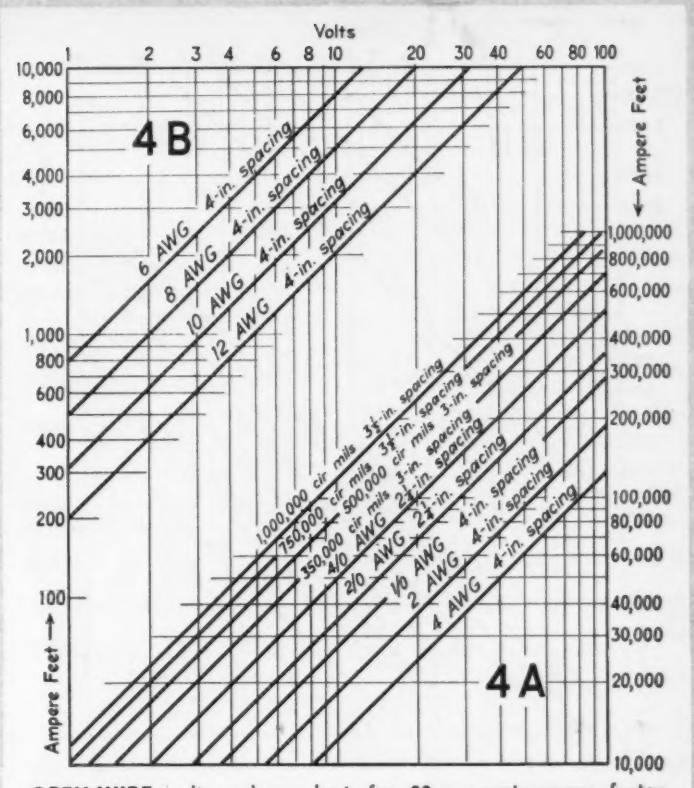


CHART OF VOLTAGE DROP for aluminum cable in *non-magnetic* conduit; 100 percent power factor loads, three single conductors at 75 C temperature. (a) Sizes 1,000,000 cir mils to No. 4; (b) No. 6 to No. 12. Circuit: 440-v, line-to-line, 3-phase, 60 cycles



OPEN-WIRE voltage-drop chart for 80 percent power factor loads; three single conductors, flat spacing at 75 C temperature. (a) Sizes 1,000,000 cir mils to No. 4 at labeled spacing; (b) No. 6 to No. 12 at 4-in. spacing. 440-v, line-to-line, 3-phase, 60 cycles

Insulated Aluminum Cable

Reactance values for aluminum cable were obtained from AIEE pamphlet, "Electric Power Distribution for Industrial Plants."

In making the calculations for these charts, load amperes were used in amounts closely following the maximum load permissible for the various sizes of cable. Since open cable may be operated at approximately double that of cable in conduit, the values for open cable were calculated using 2I. Reactance data for the aluminum cable used in making the calculations for the accompanying set of charts is shown in Table II. Open cable spacings are center-to-center.

The accompanying charts are based on 440 v, 3 phase, 60 cycle, the most common industrial distribution voltage. For 220-v, 3-phase, 60-cycle systems, the drops on the 440-v charts can be used for most calculations. Maximum variation or error will be less than 10 percent of the voltage-drop reading. This occurs only on the 100 percent power factor at the larger loads on large conductors, such as in the 1,000,000-cir mil, open cable, 100 percent power factor charts.

TABLE I
Aluminum Cable—Hard Drawn Class B Concentric Strands

Size AWG or 1,000,000 cir mils	D-C Res. at 75 C Ohms per 1000 ft	Rac/Rdc at 75 C in Air or Non-Metallic Conduit	A-C Res. at 75 C Ohms per 1000 ft
1000	0.0212	1.023	0.0217
750	0.0283	1.013	0.0287
500	0.0424	1.006	0.0427
350	0.0605	1.003	0.0607
4/0	0.101	1.001	0.101
2/0	0.159	1.000	0.159
1/0	0.201	1.000	0.201
2	0.319	1.000	0.319
4	0.508	1.000	0.508
6	0.807	1.000	0.807
8	1.28	1.000	1.28
10	2.04	1.000	2.04
12	3.25	1.000	3.25

The errors approach zero for small wire in conduit. These errors are on the low side, necessitating positive correction factors. For exacting work, a new set of charts should be made for 220 v. For 550 v, the errors are practically negligible. For other distribution voltages, separate charts should be made.

Unless the load amperes are varied approximately according to the capacity of the cable, a similar set of charts for another voltage will result in considerable error in voltage drop as here illustrated:—

1,000,000 cir mil open cable 3½ in. flat spacing, 100% pf 1,000 ft, 100 amp
For 440 v. = 254 v. to neutral
60 cycle a-c 75 C resistance = 0.0217 ohms per 1,000 ft
Reactance = 0.052 ohms per 1,000 ft.

$$V_s = \sqrt{(254+2.17)^2+(0.052\times 100)^2}$$

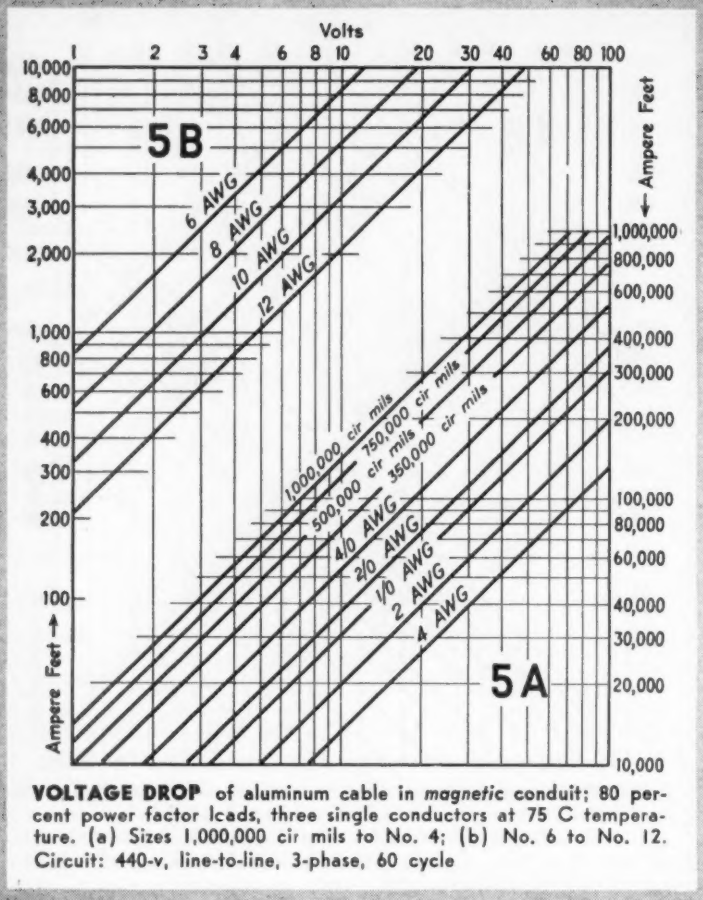
$V_{dn} = 256.225 - 254 = 2.225$
(1) V_d = 3.85 v drop for 100,000 amp ft

Same conditions except 1,000 amp

$$V_s = \sqrt{(254+21.7)^2+(0.052\times 1{,}000)^2}$$

(2) V_d = 46.0 v for 1,000,000 amp ft

From (1) 3.85 × 10 = 38.5 v drop for 1,000,000 amp ft
46 − 38.5 = 7.5 v or 16.3% error.



VOLTAGE DROP of aluminum cable in *magnetic* conduit; 80 percent power factor loads, three single conductors at 75 C temperature. (a) Sizes 1,000,000 cir mils to No. 4; (b) No. 6 to No. 12. Circuit: 440-v, line-to-line, 3-phase, 60 cycle

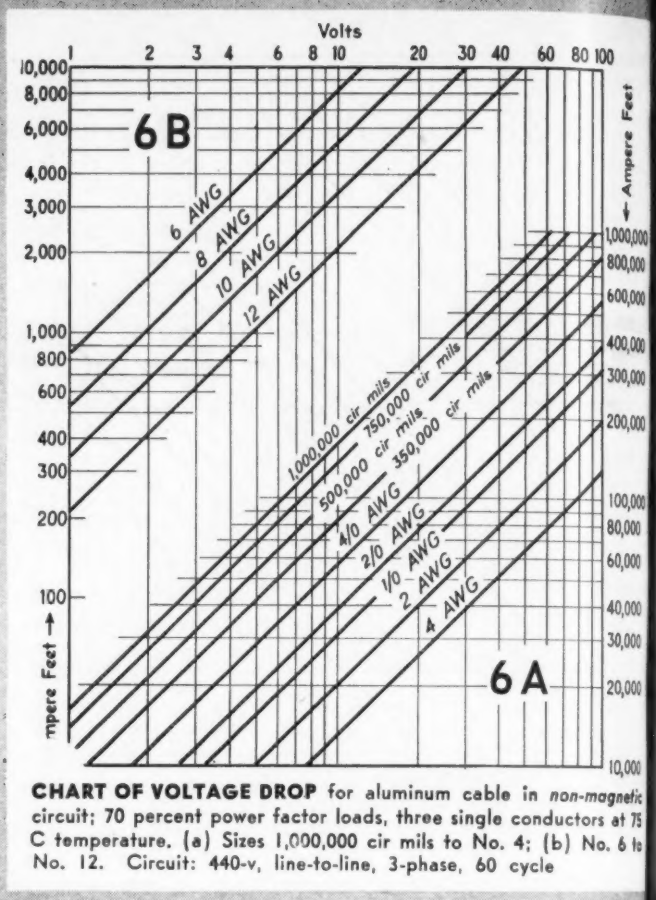


CHART OF VOLTAGE DROP for aluminum cable in *non-magnetic* circuit; 70 percent power factor loads, three single conductors at 75 C temperature. (a) Sizes 1,000,000 cir mils to No. 4; (b) No. 6 to No. 12. Circuit: 440-v, line-to-line, 3-phase, 60 cycle

Since it is convenient to plot and use straight line charts to obtain a large range in values for a short range chart, all but the 100 percent and 90 percent power factor charts on open cable for 750,000 cir mils and larger are plotted as straight lines. Any inherent error is less than 1 percent of the volts drop. The large sizes are accurately plotted for the entire 2-cycle logarithmic range for ampere-feet. This eliminates the larger errors that would exist in the volts drop readings, if these were also to be plotted straight lines.

Plotting of Data

For any particular voltage base, a number of charts are needed to cover the commonly used power factors and cable conditions. For instance, 24 charts have been provided for aluminum cable for the 440-v, 3-phase, 60-cycle system. Since it is not possible to cover the range from No. 12 to 1,000,000-cir mil cable on a single letter-size sheet, the smaller sizes have been shown on an enlarged scale. These curves are divided into three groups: (1) Open cable for 100, 90, 80 and 70 percent power factor; (2) cable in magnetic conduit for 100, 90, 80, and 70 percent power factor; and (3) cable in non-magnetic conduit for 100, 90, 80, and 70 percent power factor.

The accompanying selections are for 100 and 80 percent power factor and for open cable and magnetic conduit. Short or long circuits with light or heavy loading are easily read. Load in amperes and distance in feet are the main variables in any circuit which affect the voltage-drop calculations. The product of these, ampere-feet, is used for the ordinate. Total voltage drop is used for abscissa. By proper positioning of the decimal problems with large or small values are easily solved. For example: 250 amp on 50 ft of 500,000-cir mil aluminum cable in magnetic conduit at unity power factor can be read as 125,000 amp-ft and divided by 10.

TABLE II
Reactance Values for Aluminum Cable

Size MCM or No.	In Conduit: Non-Mag. Str. Lay X/1000 ft Ohms	In Conduit: Magnetic Random Lay X+50% per 1000 ft Ohms	In Conduit: Non-Mag. Random Lay X+20% per 1000 ft Ohms	Open: Flat Spacing	Open: Equivalent Triangular Spacing x 1.26	Open: X/1000 ft Ohms
1000	0.0275	0.0413	0.033	3.5″	4.41″	0.052
750	0.0285	0.0428	0.0342	3.5″	4.41″	0.0555
500	0.029	0.0435	0.0348	3″	3.78″	0.0563
350	0.0297	0.0445	0.0356	3″	3.78″	0.060
4/0	0.0305	0.0458	0.0366	2¼″	2.835″	0.060
2/0	0.0322	0.0483	0.0386	2¼″	2.835″	0.066
1/0	0.0339	0.0508	0.0407	4″	5.04″	0.081
2	0.035	0.0525	0.0420	4″	5.04″	0.087
4	0.037	0.0555	0.0444	4″	5.04″	0.0923
6	0.040	0.060	0.0480	4″	5.04″	0.0977
8	0.038	0.057	0.0456	4″	5.04″	0.103
10	0.038	0.057	0.0456	4″	5.04″	0.1085
12	0.042	0.063	0.0504	4″	5.04″	0.1139

ALUMINUM CABLE ENGINEERING DATA

TABLE I — Insulation Thickness and Conduit Size

Size AWG or Mcm	Number Strands	Type	Diam. Bare Cable Mils	Rubber Ins. Thickness 64ths	Rubber Ins. Thickness Mils	Neoprene Thickness 64ths	Neoprene Thickness Mils	Nylon Thick. Mils	Ins. Incl. Jacket Mils	Ins. x 2 Mils	Total Diam. Inches	Area 1 Cond. Sq. in.	Area 3 Cond. Sq. in.	Size Conduit for 3 Cond.
12	7	RU	92		9		12	5	26	52	0.144	0.01629	0.04887	½
12	1	RU	80.8		9		9	5	23	46	0.127	0.0127	0.0381	½
10	1	RU	101.9		9		9	5	23	46	0.148	0.0172	0.0516	½
8	7	RU	146		12		18	9	39	78	0.224	0.03941	0.1182	¾
8	7	RH	146	4	63	2*	31	—	94	188	0.3335	0.08735	0.26205	1
6	7	RH	184	4	63	2	31	—	94	188	0.3715	0.1083	0.3250	1
4	7	RH	232	4	63	2	31	—	94	188	0.4195	0.1382	0.4146	1¼
2	7	RH	292	4	63	2	31	—	94	188	0.4795	0.1805	0.5415	1¼
1/0	19	RH	373	5	78	3	47	—	125	250	0.623	0.3048	0.9144	2
2/0	19	RH	419	5	78	3	47	—	125	250	0.669	0.3515	1.0545	2
4/0	19	RH	528	5	78	3	47	—	125	250	0.778	0.4754	1.4262	2½
350	37	RH	631	6	94	4	63	—	157	314	0.994	0.7760	2.328	3
500	37	RH	813	6	94	4	63	—	157	314	1.126	0.995	2.985	3
750	61	RH	998	7	109	4	63	—	172	344	1.342	1.414	4.242	4
1000	61	RH	1152	7	109	4	63	—	172	344	1.496	1.752	5.256	4

*Heavier jacket than recommended by IPCEA

TABLE II — Ampere Capacity of Aluminum Cable Three Conductors or less in Exposed Conduit

(Based on 30 C, 86 F ambient temperature; 84 percent of copper ratings, compiled from 1947 National Electrical Code)

Size AWG or Mcm	60° R, RU RW	75° RH	85°V 90°AVB	110° AVA AVL	125° AI AIA	200° A AA
12	17	17	25	29	34	34
10	25	25	34	38	42	46
8	34	38	42	50	55	59
6	46	55	59	67	71	80
	Type R	Type RH	V-AVB	AVA-AVL	AI-AIA	A-AA
6	46	55	59	67	71	80
4	59	71	76	88	97	101
2	80	97	101	113	122	139
1	93	109	118	134	143	160
1/0	105	126	130	160	168	189
2/0	122	147	155	181	193	210
3/0	139	168	176	206	222	239
4/0	164	193	197	231	260	286
250	181	214	227	265	281	
300	202	239	252	290	319	
350	218	260	273	328	353	
400	235	281	302	353	378	
500	269	319	340	395	420	
600	300	353	382	442	458	
700	325	386	412	470	504	
750	335	399	420	487	521	
800	344	412	432	504	538	
900	365	437	466			
1000	382	458	492	571	613	
1250	418	496	542			
1500	437	525	588	660		
1750	459	546	618			
2000	470	559	652	706		

TABLE III — Ampere Capacity of Aluminum Cable Single Conductor in Free Air

(Based on 30 C, 86 F, ambient temperature; 81 percent of copper rating, compiled from 1947 National Electrical Code)

Size AWG or Mcm	60° R-RU RW	75° RH	85° 90°AVB	110° AVA AVL	125° AI AIA	200° A AA	SB WP
12	21	21	34	42	42	46	34
10	34	34	46	55	59	63	46
8	46	55	59	71	76	84	59
6	67	80	84	101	105	113	84
	Type R	Type RH	V-AVB	AVA-AVL	AI-AIA	A-AA	SB-WP
6	67	80	84	101	105	113	84
4	88	105	113	134	143	151	109
2	118	143	151	176	189	202	147
1	139	164	176	206	223	235	172
1/0	164	193	206	239	256	273	197
2/0	189	223	239	277	298	311	231
3/0	218	260	277	324	345	361	269
4/0	252	302	324	374	399	428	311
250	285	340	357	416	445		345
300	315	374	403	467	496		386
350	353	424	445	512	550		423
400	382	458	483	558	597		467
500	432	521	555	643	685		529
600	483	580	622	718	765		597
700	530	634	685	790	845		655
750	550	659	710	823	878		680
800	571	685	740	857	911		710
900	615	731	790				760
1000	655	785	840	979	1042		810
1250	748	895	950				
1500	822	986	1060	1219			1020
1750	900	1075	1150				
2000	970	1162	1235	1440			1180

NOTE: See 1947 Code for correction factors for other ambient temperatures. Temperatures listed are maximum allowable conductor operating temperatures.

TABLE IV — Aluminum Cable Motor Leads
Minimum Sizes for Types R, RW, RU (60 C) and Type RH (75 C) in exposed conduit

(Based on 30 C ambient temperatures; compiled from 1947 National Electrical Code)

HP	220 V. A.C. † I_s	220 V. A.C. † I_s x 125%	220 V. A.C. † Cond. Size	220 V. A.C. † Cable Size	440 V. A.C. † I_s	440 V. A.C. † I_s x 125%	440 V. A.C. † Cond. Size	440 V. A.C. † Cable Size	230 V. D.C. I	230 V. D.C. I x 125%	230 V. D.C. Cond. Size	230 V. D.C. Cable Size
				Type RU (Nylon or Braid Jacket)								
1	3.5	4.4	½	12	1.8	2.25	½	12	4.3	5.4	½	12
1½	5	6.25	½	12	2.5	3.1	½	12	6.3	7.9	½	12
2	6.5	8.1	½	12	3.3	4.1	½	12	8.2	10.3	½	12
3	9	11.3	½	12	4.5	5.7	½	12	12	15	½	12
5	15	18.7	½	10	7.5	9.4	½	12	20	25	½	10
7½	22	27.5	¾	8	11	13.8	½	12	29	36	¾	6
10	27	33.8	¾	8	14	17.5	½	10				
15					20	25	½	10				
20					26	32.5	¾	8				
25					32	40	¾	6				

HP	220 V. A.C. † I_s	220 V. A.C. † I_s x 125%	220 V. A.C. † Cond. Size	220 V. A.C. † Cable Size	440 V. A.C. † I_s	440 V. A.C. † I_s x 125%	440 V. A.C. † Cond. Size	440 V. A.C. † Cable Size	230 V. D.C. I	230 V. D.C. I x 125%	230 V. D.C. Cond. Size	230 V. D.C. Cable Size
				TYPE RH (Neoprene or Braid Jacket)								
7½	22	27.5	¾*	8	11	13.8	½	12	29	36	¾*	8
10	27	33.8	¾*	8	14	17.5	¾	10	38	47.5	1	6
15	40	50	1	6	20	25	¾	10	56	70	1¼	4
20	52	65	1¼	4	26	32.5	¾	8	74	93	1¼	2
25	64	80	1¼	2	32	40	1	6	92	115	1½	1/0
30	78	97	1¼	2	39	49	1	6	110	138	2	2/0
40	104	130	2	2/0	52	65	1¼	4	146	183	2	4/0
50	125	156	2	3/0	63	79	1¼	2	180	225	2½	300
60	150	188	2½	4/0	75	94	1¼	2	215	269	3	400
75	185	231	2½	300	93	116	2	/0	268	335	4	600
100	246	307	3	500	123	154	2	3/0	355	444	4	1000
125	310	387	4	700	155	194	2½	4/0	443	555	2—3	2—400
150	360	450	4	1000	180	225	2½	300	534	667	2—4	2—600
200	480	600	2—3	2—500	240	300	3	500	712	890	2—4	2—1000

* Use 1-in. conduit for Neoprene jacket of 2/64 in. See Table I. † 3 phase, 60-cycle inductionmotors

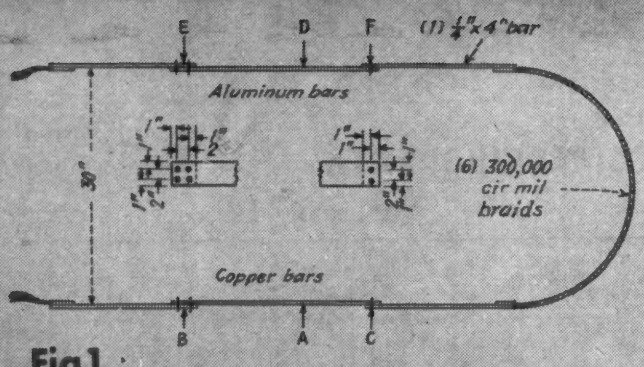


Fig 1

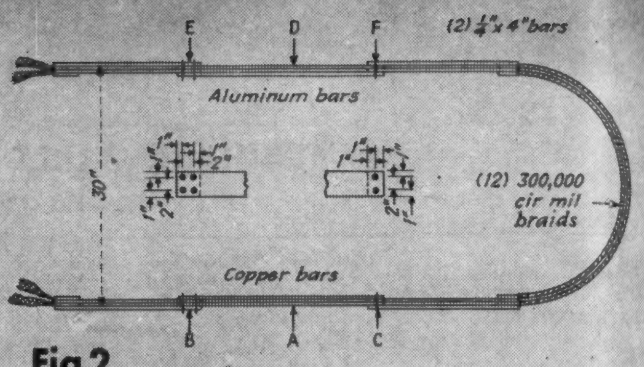


Fig 2

TEST SETUP for 1,000 amp utilizes single busbars and six 300,000-cir mil braid as shown in Fig 1; in Fig 2, current-carrying capacity is doubled, 2,000 amp, by using double bars and 12 braids. All bars were 48 in. long and were mounted with the 4-in. axis vertical

Aluminum Busbar Laps and Joints NEED NOT BE LARGER Than Copper

Commonly accepted statement "aluminum must have twice the contact area" proven false . . . Conception of necessary aluminum-to-copper contact area also confuted

STANLEY C. KILLIAN
Chief Engineer
Delta-Star Electric Co
Chicago, Ill.

LABORATORY HEAT-RUNS disprove the theory that aluminum requires larger laps and joints in busbars than copper. These tests show that with an aluminum joint properly made, a lap of eight times the bar thickness will suffice. The usual lap of 16 times the bar thickness is more than is necessary for the current-carrying capacity of the bar itself. There is also little apparent difference in the temperature rise between these two joint designs. But care must be used in making the joint.

In the case of aluminum, an oxide film forms very rapidly and precautions must be taken. Although copper can easily be cleaned with steel wool or sandpaper, it has been found that protective compounds such as No-ox-id give the best results with aluminum. This greasy substance is spread on the joint and then wire-brushed or scraped. The joint is bolted with the grease remaining on the busbar. The scraping of the joint under the grease prevents oxidation while the joint is being made. It also prevents future oxidation.

Another substance, Alcoa Electrical Joint Compound No. 1, also permits quick joints to be made. This material is painted on the joint before bolting. No further preparation or cleaning is necessary. The compound can be used on either copper or aluminum, but is not suitable for outdoor work since it was water miscible and may leach out.

The heat-runs were set up as shown in Fig 1 and 2. In Fig 1, one ¼-in. x 4-in. bar made up the bus. In Fig 2, two bars of the same size were utilized. In both cases aluminum and copper were subjected to the same tests. All bars were 48 in. long and were mounted with the 4-in. axis vertical. Lap joints tested were 2 in. and 4 in. in length. All bolts were ½-in. diam and carried 1-in. diam flat washers on both sides of the bus. The bolts were tightened to approximately 50 ft-lb.

Temperature rises listed in Table I were read with thermometers placed as shown by letters in Fig 1 and 2. Joint temperatures B, C, E, and F are recorded as maximum values. These were read from the thermometers at the joint locations.

To check the values obtained, rises for the bars themselves can be compared with the standard values for bars at 30 C rise. If the first four values given under copper bar in Table I are averaged and the square law applied, the capacity of a copper ¼-in. x 4-in. bar is found to be 1,310 amp at 30 C rise. This checks with the generally accepted value of 1,250. In a like manner, the average of Tests 5 and 6 under copper bar when corrected to 30 C rise is found to be 2,040 amp. This checks with the generally accepted value of 2,100.

Calculating the aluminum values on the same basis, it is found that one ¼-in. x 4-in. aluminum bar has a capacity of 1,020 amp. This compares with the accepted value of 1,000; and with two bars, 1,670 against the accepted value 1,650.

Joints in aluminum busbars are equally good when comparing Test 1 (made under No-ox-id), and Test 2 (made with the Alcoa compound). Both the 4-in. lap and the 2-in. lap temperature rises are less than the bar itself.

The same bars used in Tests 1 and 2 were used in Test 3 after being wiped clean of compound and polished with steel wool. With no other treatment, the joint was made up. As expected, they ran warmer than previous tests by 1 or 2 deg. But some

Table I—Temperature Rise (Deg C)
Copper to Copper and Aluminum to Aluminum Joints

Test No.	Fig No.	Amp	Copper Bar A	4"-Cu Lap B	2"-Cu Lap C	Al Bar D	4"-Al Lap E	2"-Al Lap F
1	1	1,000	16.9	17.5	16.4	28.7	26.9	28.0
2	1	1,000	16.9	18.1	16.9	29.3	26.3	28.1
3	1	1,000	17.7	17.5	16.8	28.5	27.3	29.5
4	1	1,000	17.4	18.6	17.4	30.3	30.4	35.0
5	2	2,000	29.6	28.1	28.2	44.5	42.2	43.0
6	2	2,000	29.3	28.5	30.0	42.2	39.1	41.6

Tests No. 1 and 5—Clean Aluminum joints using No-ox-id.
No. 2 and 6—Clean Aluminum joints using Alcoa Joint Compound No. 1.
No. 3 —Aluminum joints cleaned with steel wool only.
No. 4 —Untreated new aluminum bars.

Table II —Temperature Rise (Deg C)
Copper to Aluminum Joints

Test No.	Fig No.	Amp	Cu Bar D	Al Bar A	4" Cu to Al Lap B	4" Cu to Al Lap E	2" Cu to Al Lap C	2" Cu to Al Lap F
1	1-note	1,000	19.5	27.7	22.2	24.7	26.6	23.9
2	2-note	2,000	27.8	43.3	36.9	30.4	33.3	36.0

All joints cleaned with Alcoa Joint Compound No. 1
Note—Fig No. 1 and 2 modified by interchanging all center bars to result in all aluminum to copper joints.

benefit was derived from the Alcoa Compound used in the previous test, since new aluminum bars having no previous treatment showed a rise indicated in Test 4 in the table. The results obtained in Tests 3 and 4 are expected to increase with time since the joints were not protected against oxidation as in Tests 1 and 2.

All four tests on copper bars were identical to those performed on the aluminum. The copper joints, however, were cleaned with steel wool prior to Test 1. All results listed in the table are actual values. No attempt was made to correct experimental errors. The copper temperatures varied slightly, although made under supposedly identical conditions. The 2-in. copper laps ran slightly cooler than the 4-in. on single bars. This is very likely an experimental error. All such errors, however, are so minute that their presence does not affect the over-all conclusions.

Test 5, with No-ox-id, and Test 6, with Alcoa Compound, showed similar results. The tests indicate that if an aluminum joint is properly made, the shorter lap is equally as good as the longer.

Heat-runs made on copper to aluminum bars as shown in Table II brought the expected results. Set-ups were as shown in Fig 1 and 2, but the center bars of aluminum and copper were interchanged. This gave 4-in. lap joints and two 2-in. lap joints, all copper to aluminum. Temperature rises in both the 4-in. lap and the 2-in. lap were higher than for corresponding copper to copper laps, lower than corresponding aluminum to aluminum. These results disprove the theory that special attention must be given the size of aluminum joints when fastening to copper. With joints properly made, aluminum can be handled electrically exactly as copper. But, section for section, it has a lower ampere capacity.

Test 2 in Table II was repeated with cadmium-plated copper bars. Almost identical results were obtained. Alcoa Compound was used, and it was found that the cadmium surface was cleaned without injury.

Since most connectors and all switches are built of copper or its alloys, the use of aluminum conductors introduces a potential difference between the dissimilar metals. With a moist atmosphere, this causes a corrosive action. The corrosion is approximately proportional to the voltage difference between the members in the electromotive series shown in Table III. Absolute voltages shown will vary somewhat, depending on the type of solution to which the metals are exposed. But, for average conditions, the voltage differences between various metals will be nearly the same. Passivity and other phenomena will also vary results obtained by direct deduction from this table; but this series can be used as a guide.

The potential difference between aluminum and copper is very large (2.03). This difference can be divided if cadmium is interposed between them. To do this, the copper member is plated with cadmium where contact is made with aluminum. Zinc divides the difference between aluminum and copper even better than cadmium; but it is not recommended as a coating material on copper since it is absorbed by that metal. Tin and lead also split the potential difference between aluminum and copper but not as evenly as cadmium. These values and the differences in potential are listed in Table IV.

TABLE III
Electromotive Potential of Metals in Volts

(Normal metal—ion concentration solution)

Aluminum	−1.69	Nickel	−0.22
Zinc	−0.76	Tin	−0.14
Iron	−0.43	Lead	−0.13
Cadmium	−0.40	Hydrogen	−0.00
	Copper +0.34		

Table IV—Potential Difference Between Metals

Metal	Electromotive Potential	Potential Difference	Metal	Electromotive Potential	Potential Difference	Metal	Electromotive Potential	Potential Difference
Al	−1.69 v		Al	−1.69 v		Al	−1.69 v	
		0.93 v			1.29 v			1.55 v
Zn	−0.76 v		Cd	−0.40 v		Sn	−0.14 v	
		1.10 v			0.74 v			0.48 v
Cu	+0.34 v		Cu	+0.34 v		Cu	+0.34 v	

HOW

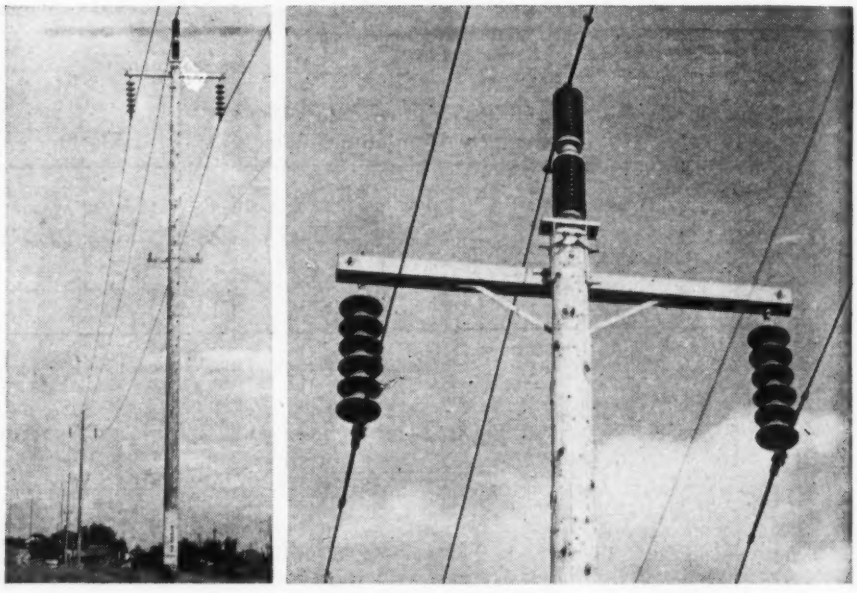
DESIGN • CONSTRUCT • OPERATE • MAINTAIN

Streamlined 110-Kv Transmission Line

EARL BAUGHN • Washington Water Power Co, Spokane, Wash.

CIRCUMSTANCES arise where it may be desired to give a transmission line as streamlined an appearance as possible. In such a case, the Washington Water Power Co adopted the interesting type of construction shown, giving the 110-kv line the appearance of one of much lower voltage. To make such construction possible, two 60-kv Ohio Brass post-type insulators were used as a unit for the pole-top conductor. The lower insulator is of the type used on substation buses and mounts on a pole top bracket. The top insulator is of the conventional line type, flange-supported to the lower insulator. Conductor is No. 4/0 ACSR.

Alternate designs considered were wishbone, and the type using two full-length arms. Both were discarded from the appearance standpoint.



110-KV TRANSMISSION LINE of unusual design meets a situation where the appearance of a low-voltage line is desired

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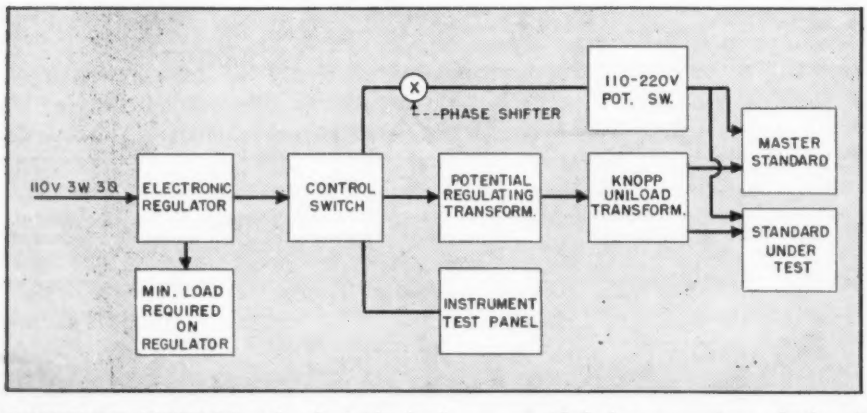
Field Standards Tested Without Sine Wave Set

FLOYD SALMON • Superintendent Meter Dept, Central Power & Light Co, Corpus Christi, Tex.

ELECTRONIC voltage regulation is used for the supply to a test panel for checking field and shop standards in the meter department of Central Power & Light Co. With this board and a standard wattmeter it is possible to check all of the test meters at intervals between the tests secured from a sine-wave laboratory.



CONSTANT VOLTAGE and adjustable load are provided for comparison checks of standard test meters and a master standard, which is in turn tested at intervals in a sine-wave laboratory

Supply is at 120 volts, three-phase, and tests may be made at 120 or 240 volts. The usual small variations that may take place in the supply voltage introduce inaccuracies. Constant voltage and constant current provided on the panel overcome these difficulties. Electronic regulators have proven satisfactory, and a Knopp Uniload transformer permits load adjustment to any desired value up to 200 amp.

A precision multi-range current transformer gives all of the standard current values needed. Through the use of this transformer, opera-

tion of the master standard is at 5 amp for all tests. The calibration of the standard is thus required at only two points, unity and 50 per cent power factor ratings.

The instrument test panel is provided with voltmeter, ammeter, wattmeter, variac and standard phantom load. A separate 240-volt service to the control switch permits special tests which do not require the constant voltage supply.

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Develop Casting Resin for Circuit Components

P. J. FRANKLIN and **M. WEINBERG** • National Bureau of Standards, Washington, D. C.

TABLE I — NBS Casting Resin Formula

Compounds	Amount by weight %
2,5-dichlorostyrene	33.0
Poly 2,5-dichlorostyrene	21.5
Styrene monomer	21.0
Polystyrene	11.0
Hydrogenated terphenyl	13.0
Solution containing 60% divinylbenzene	0.5

TABLE II — Some Properties of NBS Casting Resin

Compressive strength, lb/sq in.	17,100
Izod Impact, ft-lb/in. of notch	0.228
Coefficient of thermal expansion per deg C.	$11 / 10^{-5}$ (approx.)
Water absorption (24 hr immersion), %	0.01
Volumetric shrinkage on polymerization, %	8.0
Density of monomer	1.13
Heat distortion, deg C	68–70
Power factor (at 100 megacycles and 50% RH)	0.0004–0.0008
Dielectric constant (at 100 megacycles and 50% RH)	2.5
Dielectric strength (1/16 in. sample), volts/mil	610–660
Volumetric resistivity (megohm-cm)	$\geq 10^{17}$

As a result of experience gained in the radio proximity fuse development program at the National Bureau of Standards, a new casting resin embodying the required properties of mechanical and electrical stability was formulated through a systematic variation of resin constituents. With slight modifications to suit the intended use, the new potting compound, known as NBS casting resin, can be readily employed in many high-frequency devices requiring such mechanical-electrical insulation. This development was centered in the Ordnance Development Division of the National Bureau of Standards, Washington, D. C.

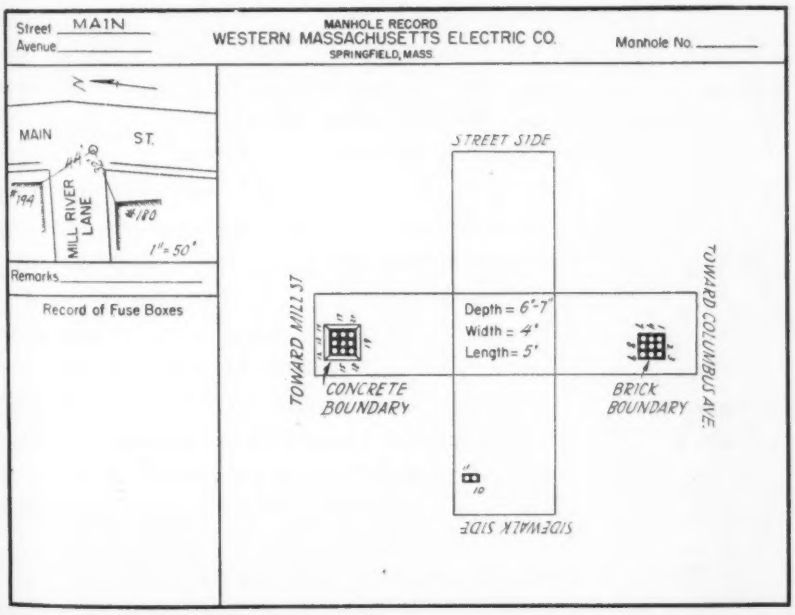
The most important properties specifically desired of a casting resin when utilized at high frequencies in high-impedance circuits are: Low power factor; low dielectric constant; short polymerization period at low temperature and atmospheric pressure; high impact strength; small volume shrinkage on polymerization; dimensional and electrical stability; and low moisture absorption. The NBS casting resin not only meets these requirements but fulfills the additional requirements of low viscosity and low surface tension, and hence may be poured through small openings.

By copolymerizing and by adding polymers as fillers to monomers, a number of suitable casting resins were produced. At present the best compound attained is the NBS casting resin, produced by the formula in Table I.

Table II lists some of the measured mechanical and electrical properties of the NBS casting resin, cured at 50 C employing 0.1 percent benzoyl peroxide as the catalyst.

The liquid resin may be stored at 0 C for a few months without a catalyst, and for a few weeks with a catalyst, before the viscosity increases

Compact Manhole Record



ON 9-IN. X 12-IN. CARDS the Western Massachusetts Electric Co, Springfield, maintains comprehensive records of manhole locations, layouts and cable runs as disposed and numbered at each duct entrance and exit, with the reverse side of each card devoted to listings of the conductors in each cable at the duct mouth, the purpose of each cable and its destination when necessary. The street layout and manhole location are mapped to a scale of 50 ft per inch, and distance of the manhole center given in relation to reference points. This is specially helpful in winter in case the street is temporarily covered with snow. Each manhole is shown on its card in flat projection and orientation as to adjacent street layouts. Space is provided for fuse box data. Normally the reverse side of the card is filled in in pencil to facilitate changes in cable and duct assignments

GENERAL ELECTRIC REPORTS ON RECENT IMPROVEMENTS

1. ***All ratings now Spirakore* design***
2. ***Sealed tanks prolong oil life***
3. ***Shielded windings, 22 kv and above***
4. ***Improved Pyranol insulating liquid***

The best distribution transformers that General Electric has ever built have been coming off our production lines during the last few years. Furthermore, our production rate has been, for several months, far greater than that of any comparable prewar period.

1. Now they are all SPIRAKORE

All General Electric single-phase distribution transformers now use the Spirakore rectangular core-and-coil construction, one of the really fundamental improvements in transformer history.

The first Spirakore transformer, announced in 1938, used a circular-shaped core, which decreased exciting current, permitted a radical reduction in size and weight, and resulted in lower prices. Later, a rectangular-shaped core was developed, still utilizing the Spirakore design and retaining its original advantages, but also permitting substantial improvement in impulse strength.

Basically, this method of winding cores from steel strip instead of assembling them from punchings produces a mechanically stronger core. Even more important, it produces a core in which the flux path is parallel with the direction of the steel's grain. This permits, in turn, the use of corisil, a cold-rolled, oriented-grain steel having superior magnetic characteristics in the direction of the grain. Spirakore transformers are small, lightweight, have high impulse strength, and low exciting current.

**Reg. U.S. Pat. Off*

IN DISTRIBUTION TRANSFORMERS

2. *They are SEALED to prolong oil life*

All General Electric Spirakore transformers above 15,000 volts, and the small and large kva ratings of all voltages, now use the sealed-tank construction.

The sealing of tanks for the purpose of prolonging the life of insulating oil has long been a feature of G-E power transformers. Now General Electric is making sealed tanks available, for the first time, in distribution transformers.

Outside atmosphere, with its harmful moisture content, is effectively sealed out by synthetic-rubber gaskets at all openings. These gaskets, compressed against stops or, in the case of the smaller transformers, against a deep-rolled flange on the tank, form a liquid-tight joint without use of cement or gasket stickers.

3. *They are SHIELDED against lightning surges*

All General Electric Spirakore transformers, 22,000 volts and above, have shielded windings.

Shielding was first introduced in the power-transformer field by General Electric in 1926. By preventing severe concentrations of voltages within the windings, the impulse strength of high-voltage transformers has been greatly increased and failures prevented. Now General Electric provides shielding in distribution transformers in the higher-voltage ratings.

High- and low-voltage coils are concentric with each other, and with the grounded core. Insulated metal shields around the coil are connected electrically to each line lead. Surges, which otherwise might produce tens of thousands of volts between adjacent layers and turns, are so distributed as to produce only a few thousand volts—stresses which the new progressive-layer insulation can easily withstand.

4. *They are supplied with an improved PYRANOL**

All General Electric Pyranol-filled transformers are now supplied with an improved Pyranol, designated as No. 1467.

Pyranol is an insulating liquid, introduced by General Electric in 1932, which permits, under the National Electrical Code, the indoor installation of liquid-filled transformers without fireproof vaults. It is chemically stable, possesses all the desirable characteristics of mineral oil, but will not burn, oxidize, sludge or form explosive or inflammable gases.

The principal difference, compared to the older No. 1488, is that 1467 Pyranol neutralizes the hydrogen-chloride gas remaining in the liquid after an internal arc, thus avoiding the formation of hydrochloric acid. Equipment insulated and cooled with this improved liquid may be handled in the same way, in case of failure, as would oil-filled equipment.

NOT A DAY'S PRODUCTION LOST

These improvements, and others, have been brought to you without causing a day's loss of production; furthermore they have been a major factor in limiting price increases. The high volume of production today is in great measure possible only because of savings in critically short materials and the use of new high-speed machines that are a part of the Spirakore improvement program. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

402-70

to a point where pouring is difficult. At room temperature the catalyzed casting resin gradually increases in viscosity and must be used in a day or two. The cured polymer may be drilled or turned on a lathe.

Some applications are: The casting resin can be employed in devices using glass vacuum tubes; objects can be suspended within the center of the casting resin; resin-potted circuits at the Bureau have given operation comparable to that of conventionally constructed devices.

The resin should be especially useful in high-impedance control devices to provide adequate protection against vibration, acid fumes, high humidity, and salt spray encountered in steel mills, plating plants and similar industries.

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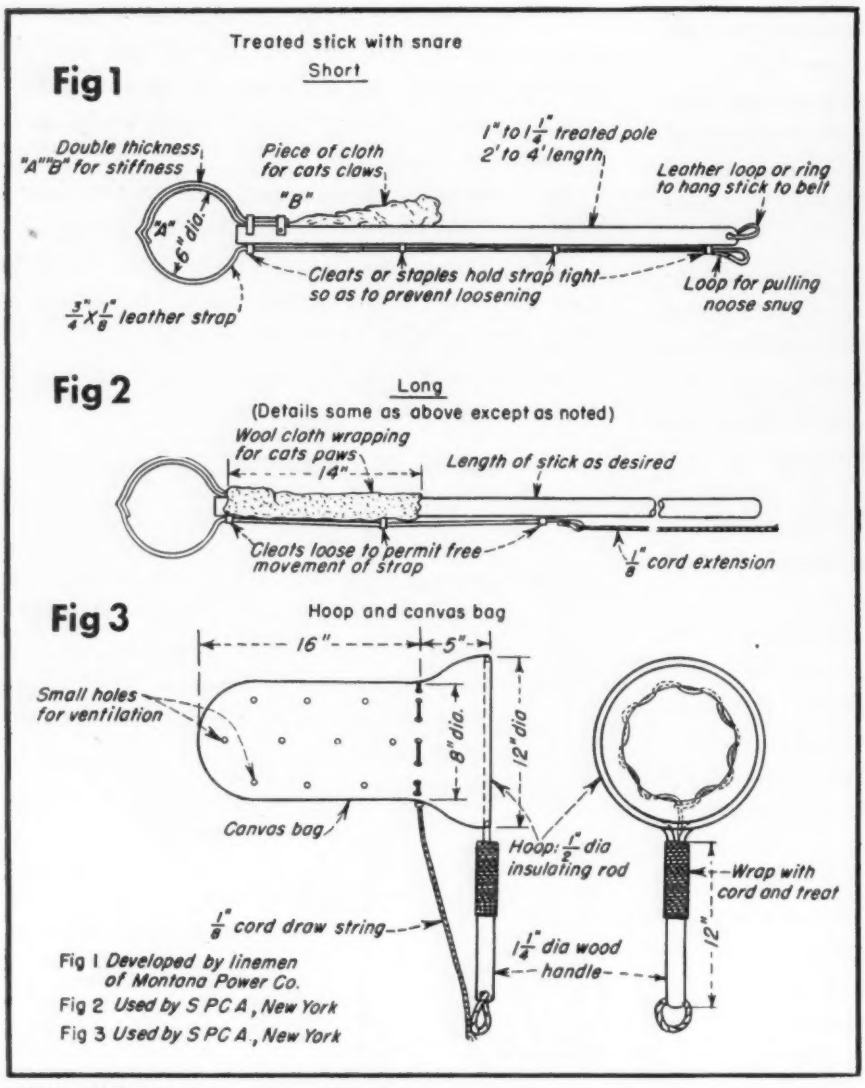
Fig 1
Treated stick with snare
Short
Double thickness "A" "B" for stiffness
Piece of cloth for cats claws
1" to 1 1/4" treated pole 2' to 4' length
Leather loop or ring to hang stick to belt
"A" 6" dia.
"B"
Cleats or staples hold strap tight so as to prevent loosening
Loop for pulling noose snug
3/4" X 1/8" leather strap
Fig 2
Long
(Details same as above except as noted)
Wool cloth wrapping for cats paws
14"
Length of stick as desired
Cleats loose to permit free movement of strap
1/8" cord extension
Fig 3
Hoop and canvas bag
16"
5"
Small holes for ventilation
8" dia.
12" dia
Canvas bag
Hoop: 1/2" dia insulating rod
Wrap with cord and treat
1/8" cord draw string
1 1/4" dia wood handle
12"
Fig 1 Developed by linemen of Montana Power Co.
Fig 2 Used by S P C A, New York
Fig 3 Used by S P C A, New York

THREE DEVICES for removing cats from poles

How To Catch A Cat

To SAVE the life of a cat, or at least rescue one that has gone courageously up a pole but seems not to know how to get down, is a problem often given to a lineman or a serviceman.

The rescuer may have his own technique, but for such a purpose the Accident Prevention Committee of Edison Electric Institute lists three suggested devices which have been developed and are in use; two with alternate arrangements have a treated stick with a snare; the third, a stick with a canvas bag. Details of each are given in the accompanying illustration.

The treated stick form (Fig 1 and 2) is available with a short or long pole, a piece of cloth for cat's claws and a snare made of leather strap with a pull cord.

When the bag type (Fig 3) is used, it is first placed under the cat's hind legs and then when the cat is in the bag the open end is closed over the cat's head.

LAGGING DRIVER—The slow procedure of using sledge hammers for driving lagging timbers employed in underground transformer vault construction gave way years ago in Pacific Gas and Electric Co practice to use of a lagging driver head mounted on an Ingersoll-Rand paving breaker as illustrated. View shows one of a number of new vaults being built by PG&E in San Francisco in connection with a large underground construction program

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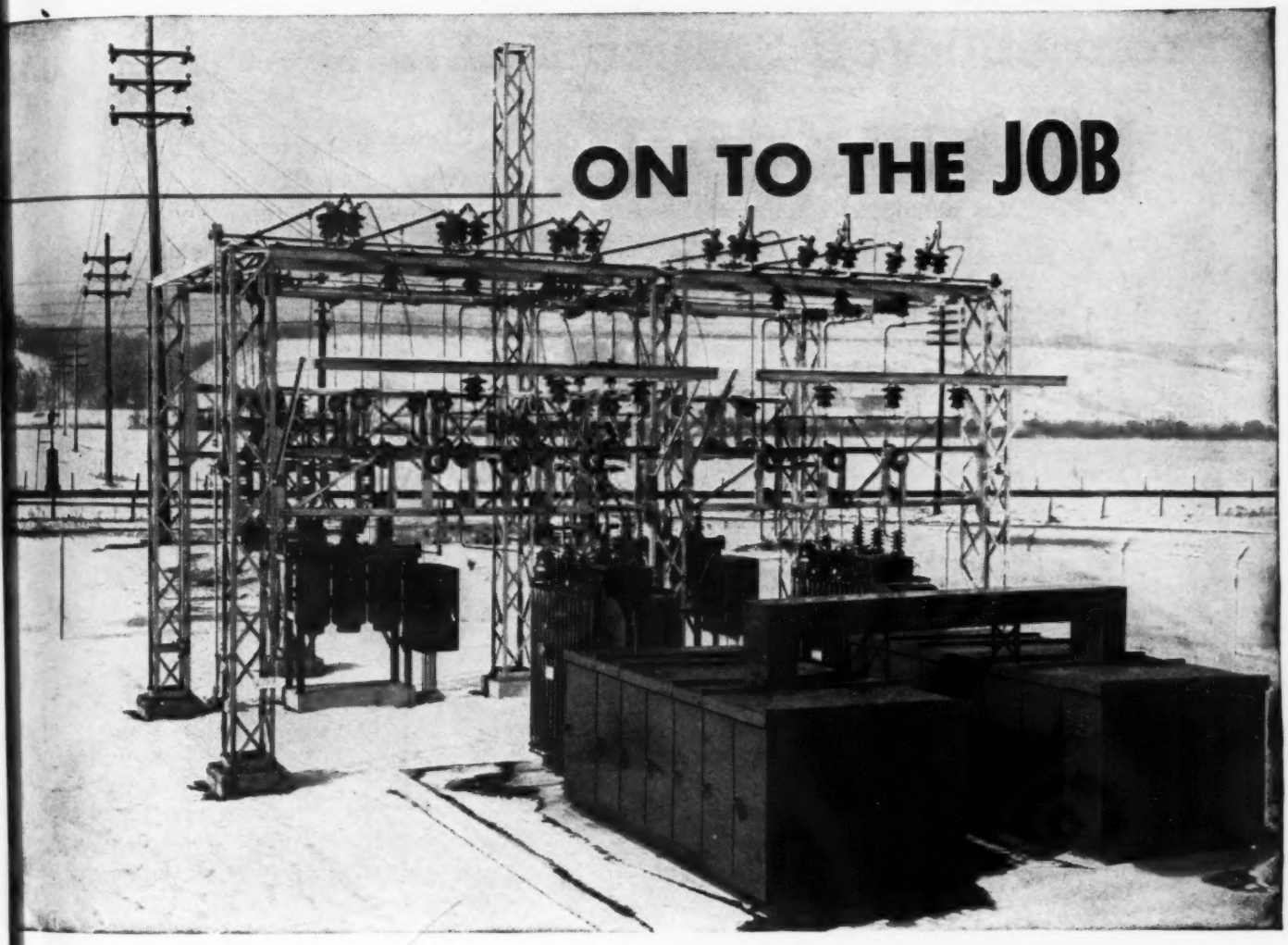
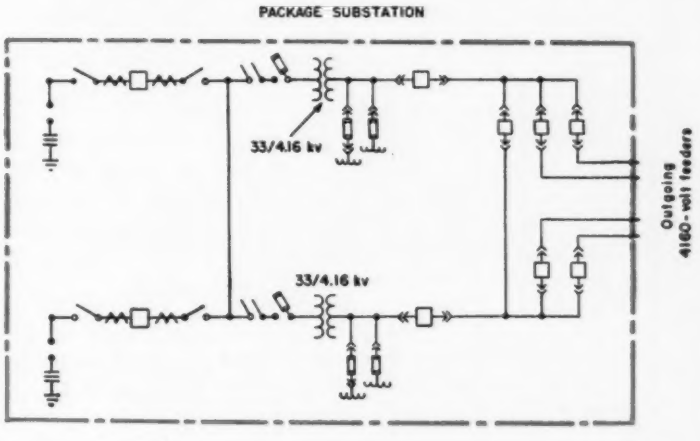
"Yeah, they're down too!"

Substation . . .



VE TIME AND MONEY WITH THE *UNIT APPROACH*
GET THE COMPLETE SUBSTATION AS A *UNIT.*

Thirty of the basic package substation arrangements e shown in GEA-4500 (left, above). Use it to investi- te the *unit approach* to your next substation applica- n. We think you'll be pleasantly surprised. Your G-E es representative will gladly provide a copy and lp you all he can. *Apparatus Dept., General Electric mpany, Schenectady 5, N. Y.*



GENERAL ELECTRIC

321-56

How to Remove Covering and Insulation From 600-Volt Station Cable

Steps preparatory to jointing cables and wires of either the same or different types used in generating stations and substations; an outline from approved methods by Philadelphia Electric Co

THE TERM "cable" is used here to designate all insulated solid or stranded single conductors, and two or more insulated solid or stranded conductors grouped together under one outer covering.

BRAID AND TAPE

Braid is split by a knife cut on a tangent to the insulation and removed by cutting away from the cable, as shown in Fig 1.

Tape is removed by unwrapping to the proper point and severing by cutting away from the insulation, as shown in Fig 2.

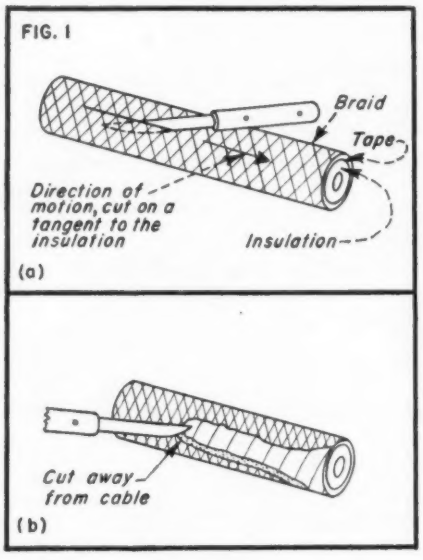
LEAD SHEATH

Lead sheath removal requires three tools—a sturdy knife, a light hammer and pliers. The usual chipping knife and hammer used by the T. & D. Underground Lines Section are satisfactory, but they may be too awkward and heavy for use on small cables in limited space.

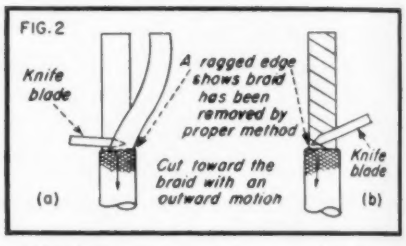
Steps to remove lead sheath are:

(A) A circumferential score is made half-way through the sheath at the proper distance from the end of the cable. The score is made by holding the knife blade perpendicular to the axis of the cable and tapping lightly on the back with the hammer as the knife is moved around the circumference. The knife must not penetrate through the sheath and damage the insulation.

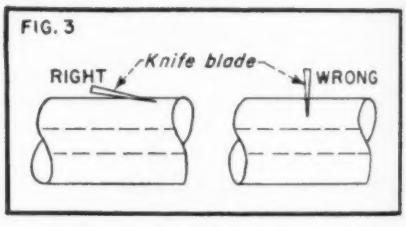
(B) Cable is scored longitudinally from the circumferential score to the end of the cable. Point of the knife is used and the blade is held at a tangent to the insulation. If the point penetrates through the lead in this position it will pass between the sheath and the insulation and no serious damage will result. The knife is forced into the sheath by tapping it with hammer.



METHOD of (a) splitting and (b) removing braid



METHOD of removing tape. (a) Tape unwraps toward braid. (b) Tape unwraps away from braid



KNIFE BLADE POSITION in removing insulation

(C) The longitudinal score should be cut completely through the sheath for ½ in. from the end of the cable. Damage to the insulation at this point is unimportant because it is later removed. One edge of the score is pried up with the knife and grasped with the pliers, and the sheath is torn off with a twisting motion. This will leave the end of the sheath slightly belled. Round off the edge of the sheath carefully so that it will not damage the rubber tape.

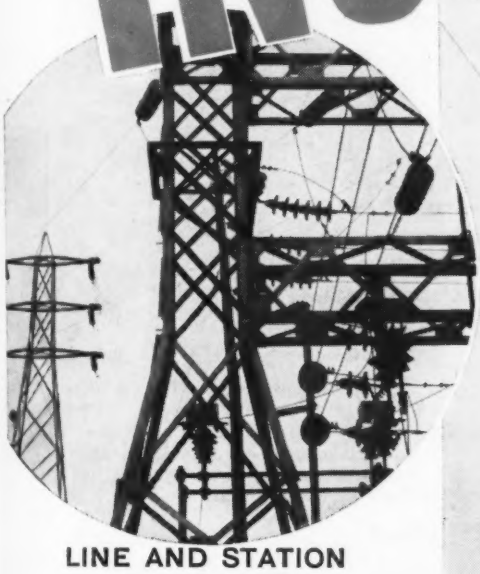
(D) On small cable, a short length, less than 6 in. of sheath, is more readily removed by making the circumferential score as in (A) and bending the cable gently and carefully at the score until the sheath parts. The short length may then be pulled off. If more than 6 in. must be removed the procedure described under (A), (B) and (C) should be followed because the force necessary to pull off a longer length might be sufficient to damage the conductor or insulation.

INSULATION

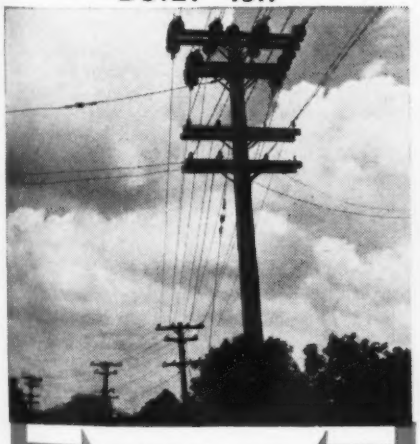
Rubber and thermoplastic insulation are removed by cutting with a sharp knife held at a small angle to the conductor. In no case should the insulation be ringed or any cut made with the knife blade perpendicular to the conductor. Such a cut is likely to damage the conductor. Any such damage will seriously weaken the conductor, especially small sizes.

Varnished cambric insulation must be secured with a cord or friction tape to prevent unwrapping during removal of the insulation and finishing the taper. The cuts are made with a sharp knife as shown in Fig 3.

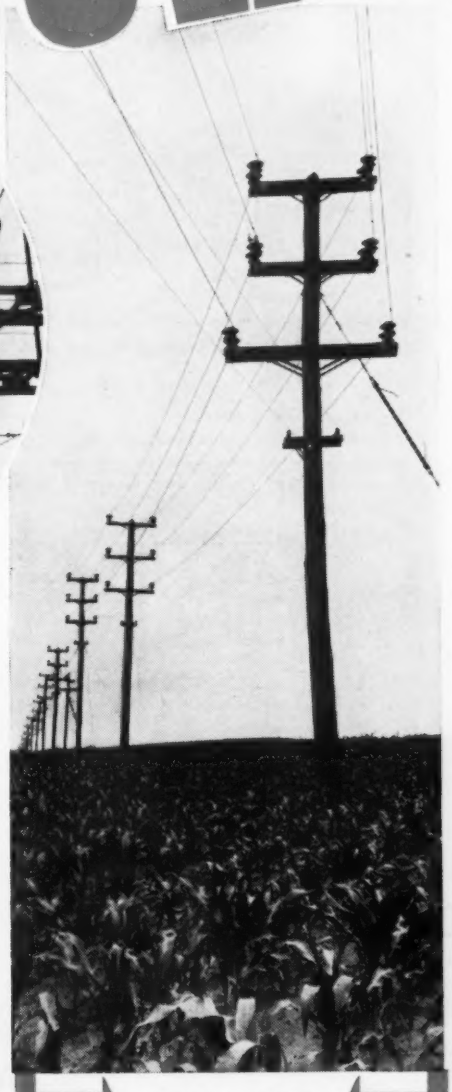
guide your INSULATORS



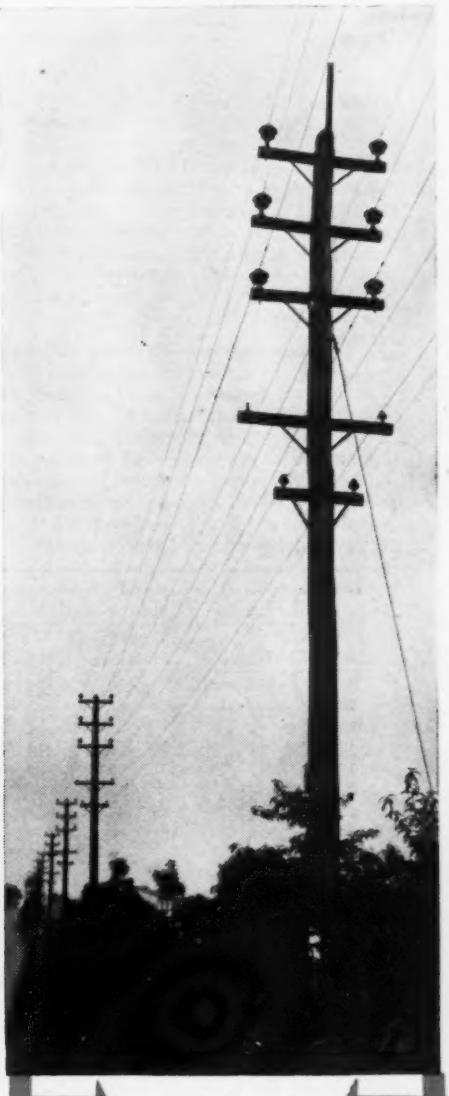
LINE AND STATION
BUILT 1917



BUILT 1917



BUILT 1928



BUILT 1914

Ohio Brass

MANSFIELD, OHIO

Canadian Ohio Brass Company, Limited
Niagara Falls, - - - Ontario

HEADQUARTERS FOR PORCELAIN INSULATION

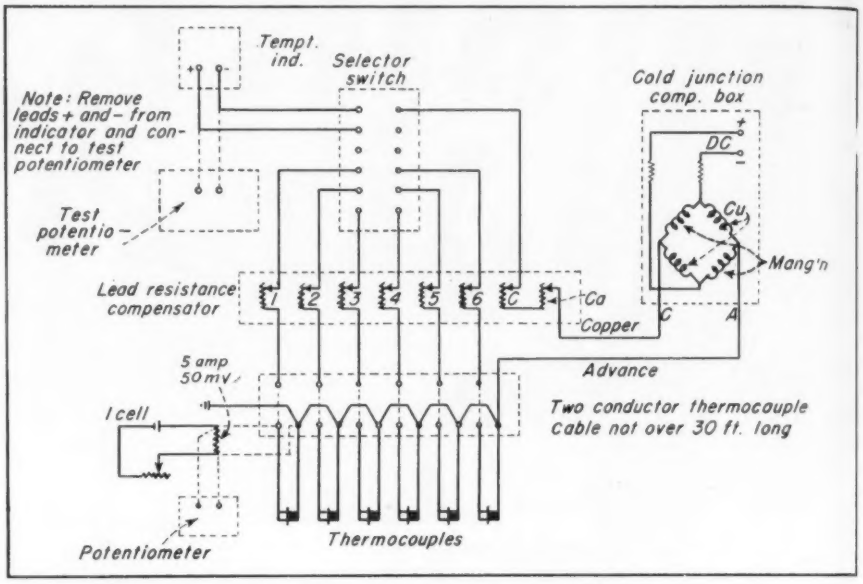
How to Maintain Temperature Indicators

V*—THERMOCOUPLE TYPE INSTRUMENT

W. F. DUNKLE
Supervisor of Electric Tests
Pennsylvania Power & Light Co, Hazleton, Pa.

A TESTING and maintenance procedure is outlined for temperature indicators operating on the thermocouple principle, with an automatic cold junction compensator operated from a separate control circuit. This type of instrument is manufactured by Westinghouse Electric Corp.

The indicator is calibrated for use with a copper-constant thermocouple circuit of definite resistance. The thermocouple circuit includes the thermocouple and its leads, all wiring shown in the diagram, transfer switch, cold junction compensator and lead resistance compensator. Total resistance of each thermocouple circuit must be adjusted to the value marked on the instrument dial.



TEST CONNECTIONS for thermocouple-type temperature indicator

1. Thermocouples are made up by joining a pair of dissimilar wires on ribbons. The hot or measuring junction preferably should be welded, although for temperatures occurring in electrical machinery or apparatus, a hard soldered joint is satisfactory. A specially selected copper-nickel alloy is used in making up the thermocouples for Style SX, HX and KX instruments and has these characteristics:

Instrument Marking for Copper Nickel Alloy Thermocouples

Scale deg C Marking	Millivolts	Scale deg C Marking	Millivolts
200	+7.660	100	+2.375
190	+7.140	90	+2.440
180	+6.630	80	+2.020
170	+6.120	70	+1.605
160	+5.625	60	+1.185
150	+5.150	50	+0.780
140	+4.685	40	+0.385
130	+4.230	30*	0.
120	+3.775	20	−0.385
110	+3.320	10	−0.780
		0	−1.185

* Note: Balance Point is at 30 deg C

2. Thermocouple Temperature Indicator must be adjusted for the thermocouples and circuits with which it is used. A slide wire resistance box is used for making these adjustments in the field. The resistance value of the circuit used in calibrating is marked on the dial and serves as a guide for field adjustments.

3. Resistance Tests on Meter and Circuits. The cold junction box, which should not be located over 30 ft from the thermocouple terminal board located on the machine, has a bridge circuit consisting of 4 coils. Two of them are manganin and should have a resistance of 0.5 ohms, each plus or minus 2 percent. The other two coils are copper and should have a resistance value depending on room temperature. See following table. Accuracy should be plus or minus 2 percent.

Temperature Table for Copper Coils

Room Temp., deg C	Ohms	Room Temp., deg C	Ohms
16	0.474	26	0.492
17	0.475	27	0.494
18	0.477	28	0.496
19	0.479	29	0.498
20	0.481	30	0.500
21	0.483	31	0.502
22	0.485	32	0.504
23	0.486	33	0.505
24	0.488	34	0.507
25	0.490	35	0.509

Two other resistance spools are located in the cold junction box and these are connected in series with the d-c control circuit. The total resistance of these spools should be 3,075 ohms for 127-volt control and 6,150 ohms for 250-volt control. Approximately ½ of the total resistance should be on each spool and the spools should be mounted in the top of the cold junction box so that heat dissipated by them does not affect the cold junction point temperature.

4. Operating Point Check of Thermocouple and Indicator.

(a) Connect indicator and compensators as shown in the diagram and apply control voltage.

(b) Set slide resistors 1, 2, 3, 4, 5, 6 and C for maximum resistance. Set slide Ca for some intermediate value of resistance.

(c) Connect a potentiometer type temperature indicator in place of switchboard instrument—refer to diagram. Set cold junction compensator of the potentiometer at the temperature of the balance point marked on the instrument which is usually 30 deg C. The cold junction compensator of the switchboard indicator will then make proper correction for room temperature. Read the temperature of all couples on the potentiometer and record these values.

(d) Immediately replace potentiometer with the switchboard indicator and adjust slide resistors C and Ca until reading of indicator is approximately correct for one of the couples.

(e) Determine the couple of highest resistance by taking the reading of all couples on the switchboard indicator and noting which couple is the greatest percent low as compared with the correct value by potentiometer. Set the slide for this couple for minimum resistance. Then adjust C and Ca until couple reading is correct.

(f) Adjust the other couple circuits by means of the slide resistors until all readings are correct when compared with potentiometer readings.

5. Zero Adjustment. The pointer should indicate balance temperature when the instrument is disconnected. Balance temperature is shown by a red mark on the scale. A zero adjuster is provided.

6. Calibration of the Instrument

(a) To check the calibration of the temperature indicator at all points, connect one dry cell battery with a slide wire resistor to a 5-amp, 50-millivolt shunt, using the shunt to replace one thermocouple unit in temperature circuit. Remove the connection to the thermocouple.

(b) Connect the standard potentiometer across the shunt so that the voltage which can be adjusted with the slide wire rheostat can be checked and compared with the values given in the scale marking table for thermocouple type instruments. See the diagram. All points on the scale can be checked by regulating the current flow through the shunt in order to secure the desired potential drop.

(c) The cold junction compensator of the potentiometer should be set for the temperature marked on the temperature indicator dial.

* This series began in ELECTRICAL WORLD, July 19, 1947, page 106.

because you wanted it.

All Simplex - ANHYDREX Underground Cables now have a neoprene jacket and they have it because you asked for it.

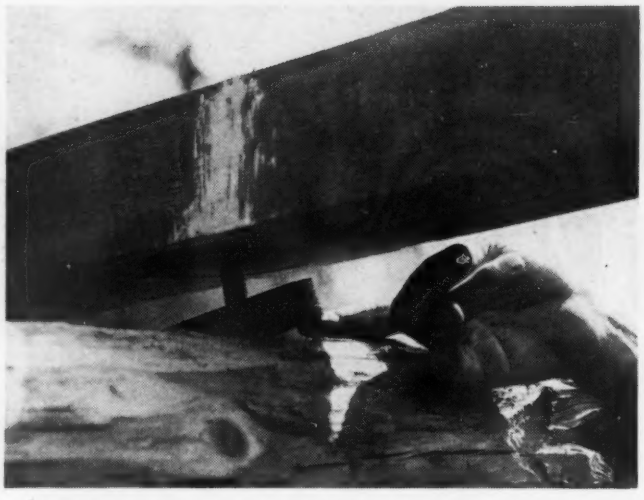
For you, a neoprene jacket on ANHYDREX cables means that you can use the cables underground with or without ducts, or you can run them up poles, or you can string them from messenger wire without having to stock a number of different kinds of cable. Neoprene jackets or sheaths aren't seriously affected by sunlight, by heat or flame. They have excellent abrasion resistance and are oil resistant.

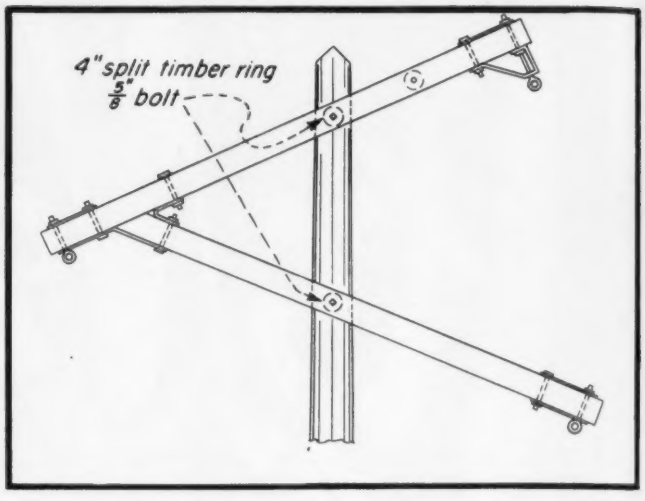
If you want to know more about the fine qualities of Simplex - ANHYDREX Underground Cables, we will be glad to send you a copy of the new edition of the ANHYDREX Underground Cable book, dated April, 1947. Write for Bulletin 985-A.

Simplex **WIRES & CABLES**

SIMPLEX WIRE & CABLE CO., 79 SIDNEY ST., CAMBRIDGE 39, MASS.

Metal Rings Boost Wood Joint Strength





TIMBER RING being placed in circular groove in pole and crossarms. Ring takes shear off throughbolt and develops greater strength; also permits use of smaller diameter bolt . . . Framing of pole and crossarm for use of timber ring is shown at right

TIMBER RINGS, long used in buildings with wood columns and beams, are being used by Portland General Electric Co in transformer structures and as shown in heavy transmission line construction. Timber rings are made of steel 4 in. in diameter, 1 in. wide and $\frac{1}{4}$ in. thick. They are placed in circular recesses cut with a special tool in the timbers to be joined. Rings are split so that when installed there is a slight spring action to make a tight fit. Depth of the circular cuts is such that half the width of the ring is imbedded in each timber. A hole is bored in the timbers in the center of the ring for a bolt to hold the pieces being joined tightly together.

Purpose of these rings, obviously, is to take the shear off throughbolts so that greater strength is developed in the timber joint. They cost only a few cents and besides permit use of $\frac{5}{8}$-in. throughbolts where $\frac{3}{4}$ or $\frac{7}{8}$-in. bolts would otherwise be required. Actually, the throughbolt serves merely to hold the timbers together, and the timber ring takes all of the shearing stress.

• • •

Use of Damper Windings on A-C Generators

II*—OVERVOLTAGES

WILLIAM L. RINGLAND
Electrical Engineer
Allis-Chalmers Mfg Co
Milwaukee, Wis.

AN EVIDENT TREND toward the more frequent requirement of damper windings on waterwheel generators is probably largely the result of a better understanding of their effect on higher than normal voltages incidental to some short-circuit conditions.

For a terminal-to-terminal short-circuit, with initial conditions no load and normal voltage, the maximum per-unit voltage across the unfaulted phase is approximately twice the ratio of quadrature-axis to direct-axis subtransient reactance minus one. A damper winding usually reduces this ratio from about 2 to about 1.4, the corresponding voltages being 3 times normal without dampers and 1.8 times normal with a damper winding. Although these voltages may be reduced by line and transformer reactance, they may also be considerably increased and more distorted in wave form by a capacitive circuit.

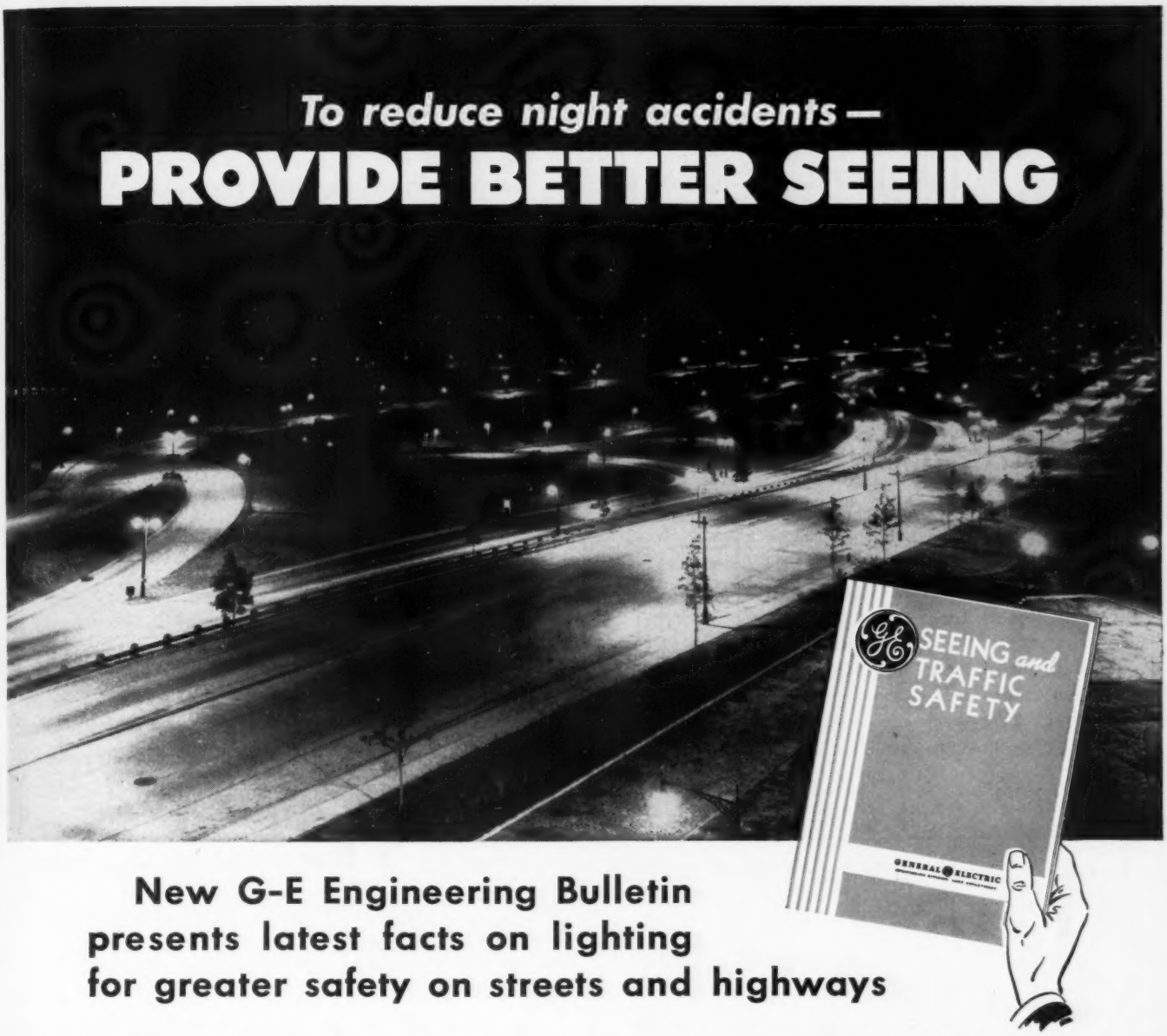
It is evident that the magnitude of these voltages can be a real hazard, the standard test voltage for new generators being only twice rated voltage plus 1,000 volts. Since the ratio of the subtransient reactances is the determining feature, purchasers' specifications are more frequently including a requirement for this ratio. It has been found that ratios as low as 1.35 are obtainable with normal design, and lower values are possible at a slight sacrifice elsewhere in the design of the machine.

A related but somewhat different situation occurs when a fault is cleared, the worst case being a symmetrical three-phase short-circuit with either the generator or the system ungrounded. The maximum per-unit voltage across the circuit-breaker terminals at the first phase to clear following such a short-circuit is 1.5 times the product of the quadrature-axis subtransient reactance and the line current at the time the phase is opened. Since the maximum current at the instant of short circuit, with normal voltage initially, is the inverse of the direct-axis subtransient reactance, the maximum possible voltage is 1.5 times the ratio of a quadrature-axis to direct-axis subtransient reactance. The two values for this ratio previously mentioned would corre-

* This series began in ELECTRICAL WORLD, August 16, 1947, page 81.

To reduce night accidents—

PROVIDE BETTER SEEING



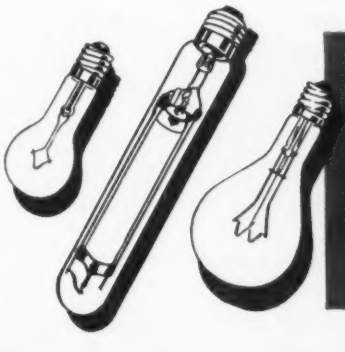
New G-E Engineering Bulletin presents latest facts on lighting for greater safety on streets and highways

MOST TRAFFIC FATALITIES occur after dark—when the rate per vehicle mile is more than 3 times that of daylight accidents. Why? Because the major night hazard is lack of adequate visibility.

What constitutes safe seeing for night driving? What is required to provide it? Too many responsible officials lack adequate information on these two fundamentals of after-dark traffic safety.

"Seeing and Traffic Safety" presents new information based on exhaustive research into every phase of visibility in night driving. It covers both automobile headlighting and fixed street and highway lighting. And it explains a practical technique developed for quantitative evaluation of street illumination.

Whatever your interest or activities in relation to traffic safety, this important General Electric bulletin belongs on your "required reading" list. To get your copy, just call or write your nearby G-E Lamp district office. *General Electric Company, Lamp Department, Nela Park, Cleveland 12, Ohio.*



G-E LAMPS

GENERAL ELECTRIC

spond to 3 times the normal voltage without dampers and 2.1 times normal with a damper winding. In practice, about 80 percent of these values might actually be experienced because of the decay of the short-circuit current before the breaker begins to open.

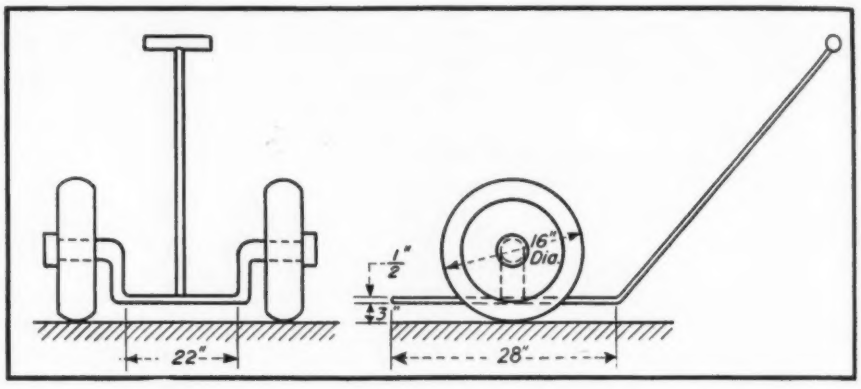
The initial rate of rise of this voltage upon opening the first phase is very rapid and is also of importance because it determines the distribution of voltage across the nearest turns in the generator or transformer winding and also affects the operation of the circuit breaker. The rate of rise will vary widely for different conditions, but it may be reduced by a damper winding to about 80 percent of its value without dampers.

A damper winding may also reduce the surge impedance of a generator to about 60 percent of its value without dampers under some conditions. Neglecting any reflections present, a surge voltage is distributed throughout a circuit proportional to the surge impedance of the circuit elements. A reduction in generator surge impedance may therefore result in a nearly proportional reduction in the surge voltage appearing at the generator.

• • •

Low Lift Transformer Cart

TILTING a distribution transformer enough to permit the edge of a steel platform to slide below is all the lifting required on a carriage used in the repair shop of Gulf States Utilities Co, Beaumont, Tex. The platform is about 22 in. by 28 in. and in moving position it has a 3-in. clearance to the floor. The wheels are 16-in. diameter, with rubber tires.



SMALL TRANSFORMERS are easily moved in the shop with this two-wheel, rubber-tired cart

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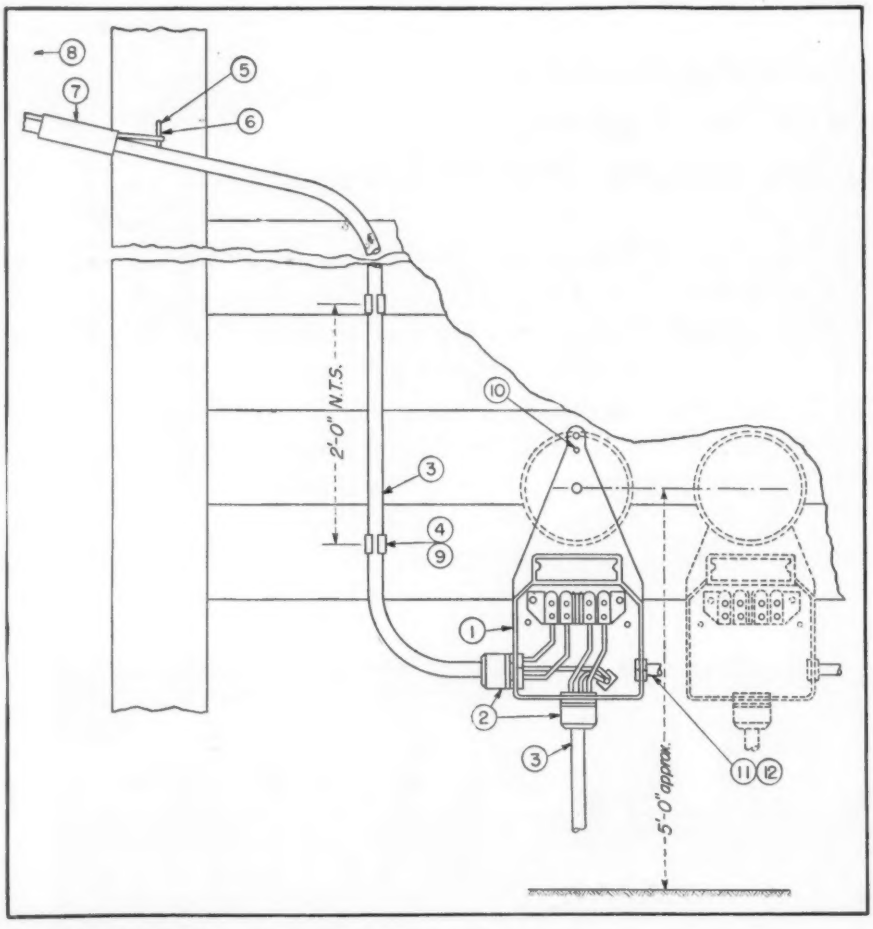


TYPICAL OUTDOOR and home service meter job

Standardizing Outdoor Meter Installations

TO ESTABLISH uniform outdoor metering and associated services, the United Illuminating Co, New Haven, Conn., has set up the accompanying layout, providing for one or more

Principal Material for Outdoor Meter Work

Item	*Quantity*	*Description*
1	1	Outdoor Meter Box
2	2	Watertight Connector
3	*	Service Cable
4	*	Cable Clips
5	1	Lag Hook
6	1	Expansion Shield if required
7	2	Cable Clamps
8	3	Connectors
9	*	Screws (Note A)
10	3	Screws (Note B)
11	*	½ in. Conduit (Note B)
12	*	No. 12 R.C. Wire (Note C)

* As required

NOTES

A. On houses with wood or shingle siding use 1-in. No. 10 brass flat-head wood screws. On brick or stone walls use ¼-in. expansion shields with 1-in. x ¼-in. x 20 flat-head brass machine screws.

B. On houses with wood or shingle siding use 1½-in. No. 12 brass round-head wood screws. On brick or stone walls use ¼-in. expansion shields with 1½-in. x ¼-in. x 20 round-head brass machine.

C. Where two-dial range-water heater meter is used, two No. 12 R.C. wires for water heater should be installed in ½-in. conduit.

Prefabrication Means Known Performance

With BullDog BUStribution DUCT

THERE are two ways to install electrical systems.

One way—*the old way*—is to have the system fabricated on the job site. Until the installation is complete, such vital operating characteristics as voltage drop and temperature rise will be deep, dark mysteries.

Voltage drop can plague your plant by cutting the power and efficiency of motors . . . dragging the output of lighting fixtures down below par. And excessively high operating temperatures are bound to take their toll by impairing performance and shortening the life of the electrical systems.

No Other Systems Offer So Much

The *new way* is the BullDog way, where prefabrication means known performance. BullDog Plug-In Type and BullDog Lo-X Feeder Type BUStribution DUCT are both built in standardized, prefabricated sections, laboratory-tested to provide accurate performance data *in advance of installation.*

No other system can offer this cost-saving feature, so call your nearby BullDog field engineer and learn more about the many advantages of BullDog BUStribution. He'll show you a successful installation near your own plant . . . and he'll be on the job to help when the time comes to design your system.

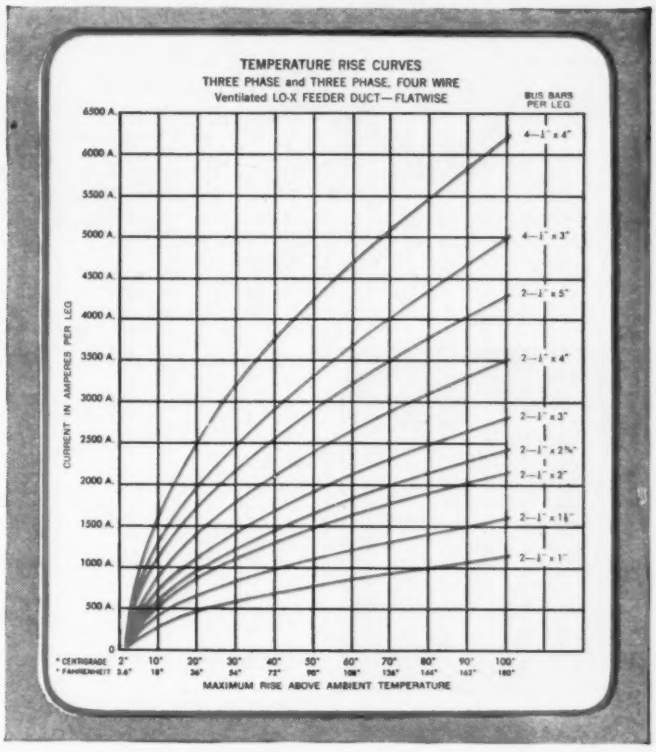
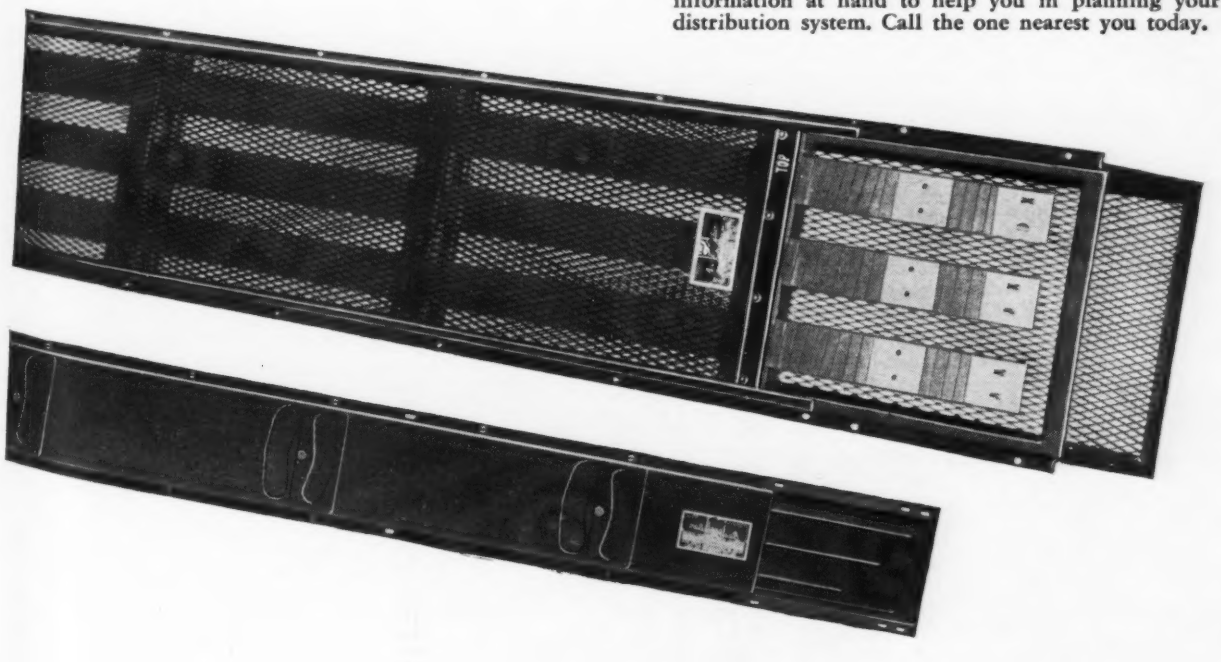


Chart shown is typical of the data on voltage drop and temperature rise available in advance of installation for all types of BullDog BUStribution DUCT. BullDog field engineers have this information at hand to help you in planning your electrical distribution system. Call the one nearest you today.



ADEQUATE WIRING SERVES AND SAVES

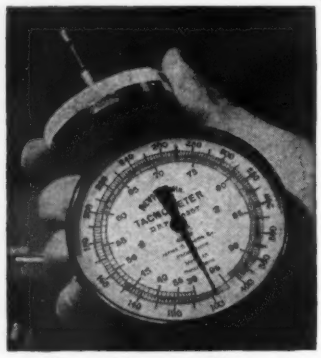
BULLDOG

ELECTRIC PRODUCTS COMPANY

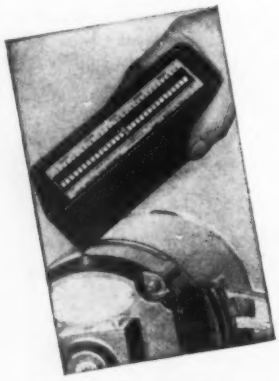
Detroit 32, Michigan. Field Offices in All Principal Cities. In Canada: BullDog Electric Products of Canada, Ltd., Toronto

BullDog manufactures Vacu-Break Safety Switches—SafToFuse Panelboards—Superba and Rocker Type Lighting Panels—Switchboards—Circuit Master Breakers—"Lo-X" Feeder BUStribution DUCT—"Plug-in" Type BUStribution DUCT—Universal Trol-E-Duct for flexible lighting—Industrial Trol-E-Duct for portable tools, cranes, hoists.

"Jagabi" Hand Tachoscope
Bulletin 1790-W.



"Jagabi" Type "A" Universal Tachometer. *Bulletin 1795-W.*



"Frahm" Vibrating Reed Tachometer. *Bulletin 1810-W.*

Over the past 30 years the Biddle Company has been a source for precision speed measuring instruments that have consistently demonstrated superior quality, high accuracy and dependability in service. Carried in stock are a variety of types and ranges of instruments for measuring rotational and surface speeds, rates of vibration and speeds of totally enclosed machines . . . helpful in the solution of your engineering problems. We shall be pleased to quote on your needs. Send for literature today.

"Jagabi" Speed Indicator
Bulletin 1815W.

Jones Heavy-Duty Tachometer
Bulletin 1710-W.

James G. **BIDDLE CO.**

ELECTRICAL & SCIENTIFIC INSTRUMENTS

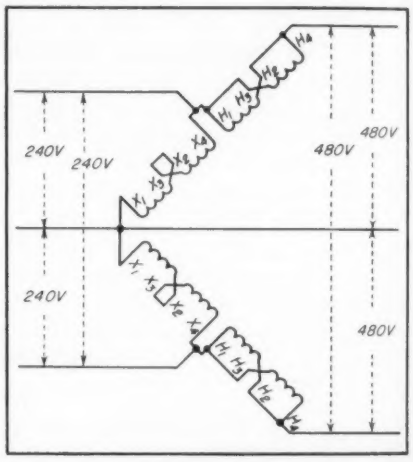
1316 ARCH STREET • PHILADELPHIA 7, PENNA.

meters as indicated. Mounting is normally about 5 ft above the ground, and service entrance cable is employed in quantities determined by each installation. Screw, conduit and wire requirements are as indicated in the notes, A, B and C with the table.

•

Standard Transformers as 2:1 Autotransformers

R. C. SCHMITZ
Commercial Engineer
American Transformer Co
Newark, N. J.



TWO DOUBLE-WOUND, dry-type, general purpose transformers connected as autotransformers in a 3-phase, open-delta connected bank for transforming from 240 volts to 480 volts, 3-phase, 3-wire (or vice versa) for power circuits where use of autotransformers is permissible

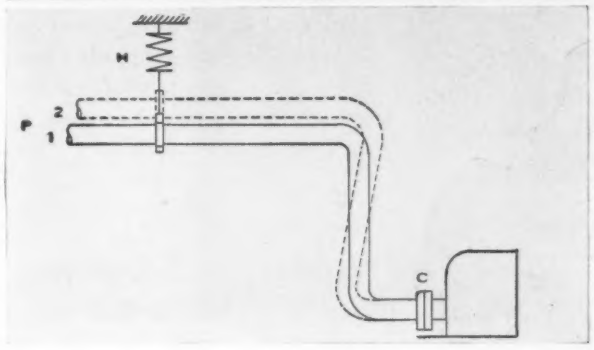
ADAPTATION of two standard single-phase, double-wound general purpose transformers as autotransformers provides a medium of 3-phase, 3-wire transformation on power circuits for utilization of equipment on 480-volt or 240-volt circuits, as the case may be.

Consider, for example, an industrial load where it is necessary to obtain 480-volt, 3-phase service from a 240-volt, 3-phase circuit and two 2-kva, 240/480—120/240 volts, single-phase, double-wound transformers are available.

Connecting a general purpose transformer as an autotransformer for a 2:1 transformation doubles the output capacity based on double-wound kva rating. The two transformers are first connected as single-phase autotransformers and then connected in a

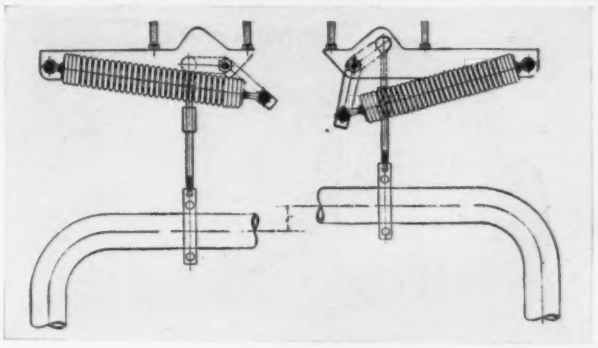
Are Weight Transfer Stresses Endangering Your Piping System?

THE PROBLEM:

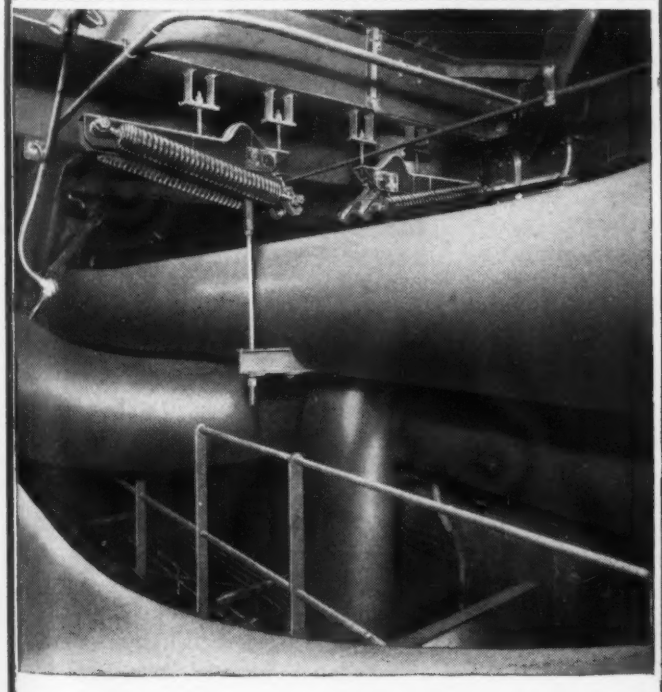


If the full safety factor is to be maintained in piping, then any weight transfer stresses caused by vertical movement of piping due to expansion or contraction, load change, surge or vibration must be eliminated. Diagram illustrates this problem—if pipe hangers "H" do not support full weight of the piping "P" in both cold position "1" and hot position "2", then dangerous stresses may result at connections "C".

THE SOLUTION:



Provide constant support to the piping throughout the entire range of vertical movement with Grinnell Constant-Support Hangers—the *only* constant support hangers. A lever, turning on the main pivot, balances the weight of a vertically shifting load because the change in moment arm with lever rotation is such that the product of the moment arm and the spring force is always constant and balances the weight of the piping system.

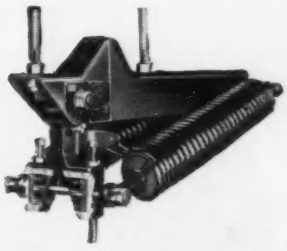


Main steam line at Hell Gate Station of Consolidated Edison Company is provided constant support by Grinnell Constant-Support Hangers.

GRINNELL CONSTANT-SUPPORT HANGERS

FEATURES:

- Constant support of piping in all "Hot" and "Cold" positions.
- Full safety factor of the supported system is always maintained.
- Non-resonant, energy absorbing.
- Mass-produced from standard precision parts.
- Individually calibrated for each installation.
- Load-adjustment features incorporated into the design.



- Three models meet entire range of load-travel specifications.
- Minimum headroom required.

Write for data book containing complete details.

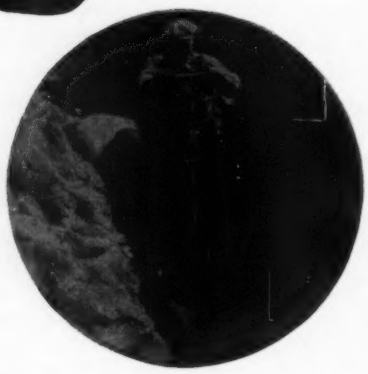
GRINNELL COMPANY, INC.
Executive Offices, Providence 1, R. I.
Branch warehouses in principal cities.

GRINNELL

FOUNDED 1850

WHENEVER **PIPING** IS INVOLVED

Utilities use **SCHRAMMS** *on jobs like these*



Three of many uses for Schramm Air Compressors in the Utility field! First, second and third are all hard jobs . . . but done easily, quickly, economically when Schramm is furnishing the air.

Schramm Air Compressors offer features to give a continuous flow of air with minimum maintenance: (1) 100% water cooled (2) Forced Feed Lubrication (3) Mechanical Intake Valve (4) Compact, lightweight.

Schramm units range in size from 20 to 420 cu. ft. actual air. For full details and construction features write us today

Let **SCHRAMM** *help you on your compressed air job!*

SCHRAMM INC. THE COMPRESSOR PEOPLE WEST CHESTER PENNSYLVANIA

2-phase open-delta connected autotransformer bank as shown by the diagram. The parallel-connected high-voltage windings of each transformer are connected in series with the series-connected low-voltage windings to form a 480/240-volt, single-phase autotransformer.

Accordingly the output of each single-phase autotransformer is 2×2 kva or 4 kva, and the 3-phase autotransformer bank output capacity becomes $0.866 \times 2 \times 4$ kva or 6.93 kva output or, generally speaking, the 3-phase bank output is 3.46 times the double-wound kva rating of one unit of bank.

•

Wattmeter Developed For U-H F Circuits

A CALORIMETER-TYPE wattmeter that can measure ultrahigh-frequency energy accurately and absolutely in one-thirtieth to one-sixtieth the time previously required was designed at Harvard University during the war, according to a report made available by the Office of Technical Services, U. S. Department of Commerce, Washington, D. C. The report, prepared by W. R. Rambo, describes work done at Harvard's Radio Research Laboratory, under a special war-time contract with the Office of Scientific Research and Development.

The wattmeter can handle continuous-wave power as high as 150 watts in the 1,000 to 3,000 megacycle frequency range. This enables an operator to obtain in 10 to 15 sec a reading that in other types of wattmeters would take from approximately 5 to 15 min.

Outstanding feature of the Harvard wattmeter is the use of a novel, sturdy 15-in. coaxial resistive circuit for transforming radio-frequency energy into heat. The circuit consists of two sections in series: a 9-in. attenuating line using the dielectric (running tap water) to absorb the energy converted into the heat; and a 6-in. untuned matching line for coupling the input impedance of the attenuating line with the normal characteristic impedance of the coaxial transmission cable. The matching dielectric is an exponentially tapered body of titanium dioxide.

The metallic outer conductors of

BARS require minimum space, may be bent or twisted, connected to apparatus without special joint preparation and in laminated construction have unlimited d.c. capacity.

TUBES provide the highest bus conductor efficiency at a.c. frequencies, have greater rigidity, and may be oil or water cooled.

CHANNELS have large surface area, reduce temperature rise, provide greater rigidity than tubes for long runs and have flat surfaces for tap-off.

ANGLES for ventilated hollow busses have highest rate of heat dissipation, handle greater current density, but require more space for installation.

CABLES solve many problems in conducting extremely heavy currents in confined space or in connecting moving apparatus such as furnaces of the arc or resistance types.

Ventilated COPPER CHANNEL BUS

for rigidity, good distribution and low power losses

TWO COPPER CHANNELS arranged to form a hollow square tube with longitudinal ventilating slots vertically above one another offer many advantages.

Possessing greater rigidity than a round tube, they permit long spans between bus supports, and provide good current distribution at normal power frequencies with low power losses. The flat surfaces permit inexpensive tap-offs, the large areas dissipate heat, and the simplicity of arrangement makes for low installation expense.

Each of the five shapes in which Anaconda Bus Conductors are made offers advantages of its own. In all five shapes, Anaconda Copper provides the high thermal and electrical conductivity, strength, toughness and corrosion resistance which make *copper* the preferred material for Bus Conductors.

ANACONDA

Anaconda

BUS CONDUCTORS

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

something NEW in tool belts

PATENT APPLIED FOR

"KLEIN-LINE" TOOL BELT with the sliding trace

The "Klein Line" Tool Belt—new in design—provides increased comfort and convenience and a maximum factor of safety to the lineman.

The distinctive feature of this new belt is the Sliding Trace. Made of "Klein-Kord" (the same proved material used in our safety straps), the Sliding Trace is mounted on the cushion and carries the drop-forged tested single bar Dee rings. The trace slides freely through alloy steel guides, allowing movement of approximately 6 inches in either direction. Thus, the lineman is relieved of chafing often caused by conventional belts, and undue safety strap wear is prevented.

Other construction features of the new "Klein-Line" Belt include: 2-inch wide heavy harness leather belt strap with drop-forged buckle; 1-inch wide harness leather tool loop strap securely riveted to the main strap; and 4½-inch wide cushion of pliable latigo leather with rolled edges and canvas interlining. All sewing is lock stitched with hot waxed linen thread—all rivets solid copper hand set. Furnished complete with plier pocket, tape thong and knife snap.

Ask Your Supplier

Foreign Distributor: International Standard Electric Corp., New York

A copy of the Klein Pocket Tool Guide, showing the Klein line and containing valuable tool information, will be sent on request.

Mathias KLEIN & Sons

Established 1857 — Chicago, Ill., U.S.A.

3200 BELMONT AVENUE, CHICAGO 18, ILLINOIS

both sections are 0.375 in. in diameter; and the inner conductors, 0.05-in. An axial silvered hole through the titanium dioxide dielectric constitutes the inner conductor for the matching section; and a Cromax wire, for the attenuating section.

A thermocouple placed across the inlet and outlet of the tap water running through the attenuating section generates an electromotive force in proportion to the amount of heat absorbed by the water. A meter measures the force. Since the heat represents the converted radio-frequency power, the measurement of the electromotive force is also a measurement of the radio power.

The report contains an appendix that shows how to determine mathematically the approximate dimensions of an exponential taper of titanium dioxide for coaxial resistive circuits.

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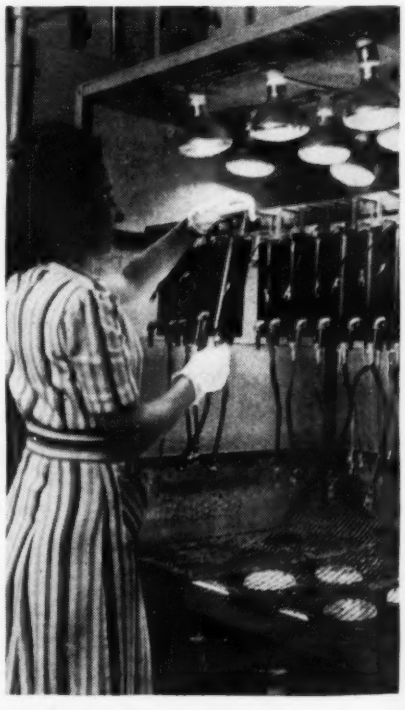
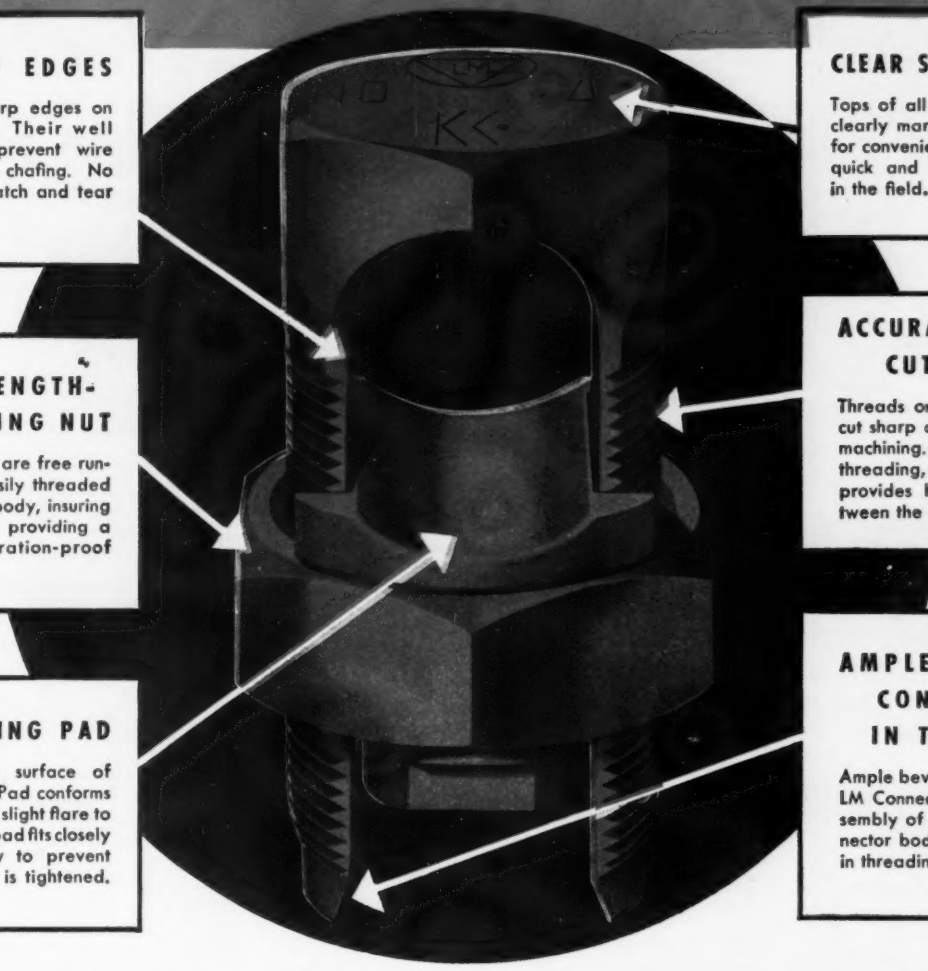
Infrared Dries Paint, Speeds Tube Production



FINISH PAINT COAT on these Ignitron rectifiers is dried by infrared in 10 min in the Westinghouse electronic tube plant at Bloomfield, N. J. Fifteen 250-watt self-contained reflector infrared heat lamps mounted above the rack, and the same number below it, do the job. This drying method permits a continuous operation of spraying, hanging and removing which was impractical with the former air drying system

When You Buy Electrical Connectors Insist on These LM Features



NO SHARP EDGES

There are no sharp edges on LM Connectors. Their well rounded edges prevent wire from nicking and chafing. No sharp edges to catch and tear lineman's glove.

HIGH STRENGTH-FREE RUNNING NUT

LM Connector nuts are free running. They are easily threaded full length of the body, insuring a good grip and providing a long lasting, vibration-proof connection.

CLOSE FITTING PAD

Rounded bearing surface of the LM Connector Pad conforms to wire. Ends have slight flare to avoid nicking. The pad fits closely in connector body to prevent collapse when nut is tightened.

CLEAR SIZE MARKING

Tops of all LM Connectors are clearly marked as to wire size for convenience. This makes for quick and easy indentification in the field.

ACCURATE MACHINE-CUT THREADS

Threads on LM Connectors are cut sharp and true by accurate machining. This assures easy threading, minimizes friction and provides highest pressure between the connected wires.

AMPLE BEVEL FOR CONVENIENCE IN THREADING

Ample bevel on the open end of LM Connectors allows easy assembly of nut and pad to connector body, acting as a guide in threading.

Line Material Split-Bolt Connectors Have Ample Strength—High Conductivity

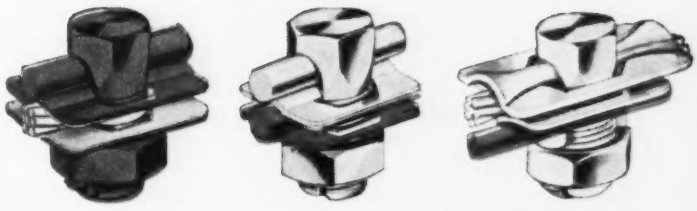
Line Material Split-Bolt Connectors, designed and manufactured by the Kyle Corporation, are available in sizes and types to take care of all connections commonly found in the field.

They are constructed of a special bronze, selected for exceptional strength and high conductivity. Yield point is considerably higher than normal use requires. This allows a more positive grip, a tighter contact.

Whether the required connection is for copper, aluminum, or steel, there is a Line Material Split-Bolt Connector to give the best possible connection.

Ask your Line Material Representative for information on the full line of LM Connectors.

For Every Type of Electrical Connection Requirement



COPPER TO ALUMINUM

Bronze LM Connector with 2 bi-metal washers to accommodate wire sizes from No. 2 Solid Copper to No. 4/0 Stranded Copper; No. 4 ACSR to No. 4/0 ACSR.

STEEL OR ALUMINUM TO COPPER

Cadmium Plated Bronze LM Connector with two plated washers to accommodate wire sizes from No. 6 Solid to No. 4/0 Stranded.

ALUMINUM TO COPPER

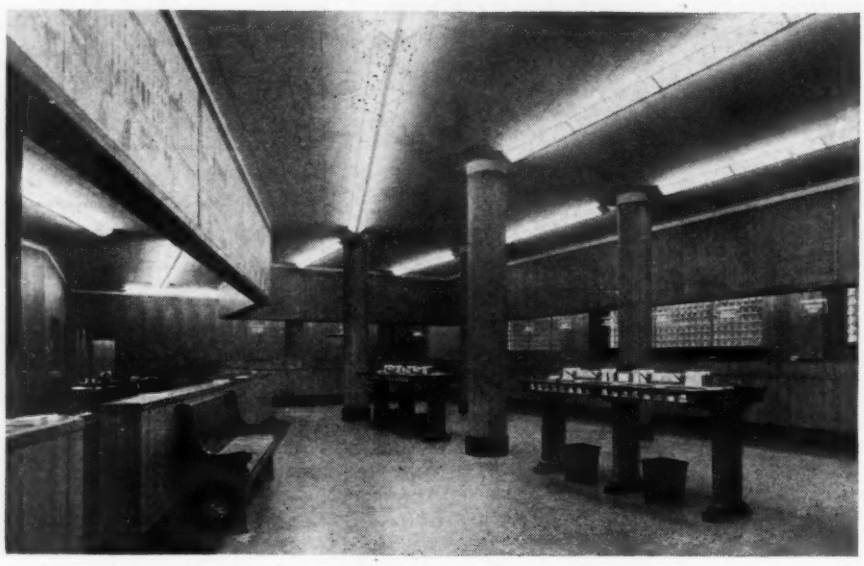
Cadmium Plated Bronze LM Connector with 1 flared aluminum washer and 1 bi-metal washer for wire sizes from No. 2 Solid to No. 1 Solid Copper; No. 4 ACSR to No. 2 ACSR.

MADE BY KYLE CORPORATION SOUTH MILWAUKEE WISCONSIN

SOLD BY... LINE MATERIAL COMPANY MILWAUKEE WISCONSIN

LOAD BUILDING

Fluorescent Installation Solves Unique Lighting Problem



EFFECTIVE PLACEMENT OF LIGHTING meets requirements of irregular space and illumination of murals in bank

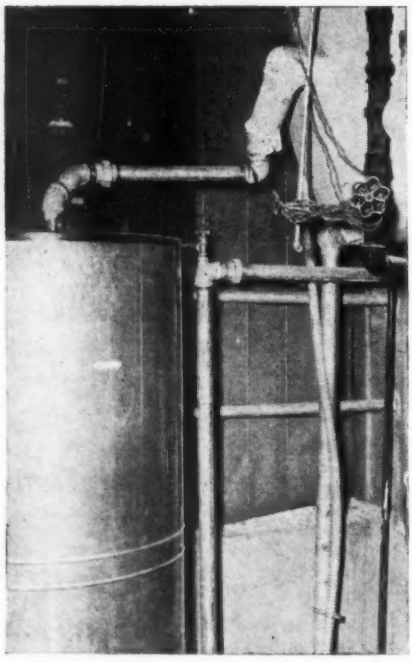
NEW QUARTERS of the Home Savings Bank in Boston, Mass., are irregular in shape. This, plus requirement of illumination of historical murals on part of the spandrel wall around the main room, posed a special problem for the lighting engineer. It was solved, as shown in the accompanying picture, by the use of discontinuous rows of V-section fixtures close up to the ceiling. The fixtures contain 2, 3 or 4 40-w fluorescent tubes according to location and lighting requirement. Intensity is 35 to 40 ft-c.

Additional to the 18-kw lighting load are others that bring the total up to about 60 kw. Included are an air-conditioning system, elevator, and refrigerator and range for employee use.

• • •

Water Heating—Summer Load Builder

A. W. AMES
Seattle City Light
Seattle, Wash.



COMMERCIAL TANK of 100-gal capacity connected as circulator to an existing 200-gal storage tank is the only supply for 16 apartments with 29 people. 13.5-kw average demand on 15-kw installed capacity gives uniform consumption of 7,800 kwhr per month. Load factor is 80 percent. Electric tank displaced 120,000 Btu-per-hour gas-fired tank

WATER HEATING in an automatic storage tank is one of the highest load-factor pieces of business for a utility. Seattle City Light has profited by this in its residential all-electric rate to the extent of an average residential consumption of 8,057 kwhr per year. To carry the idea into the commercial field, some hundred installations have been made during the past year with a new commercial tank designed for the purpose. On the premise that commercial water heating was a decidedly different problem from residence water heating, it was approached from another angle.

Results so far have been very gratifying. Size of this tank is standardized at 100 gal. Electric elements may be any wattage up to 15 kw, installed in accord with the demands of the particular job. The objective wattage to install in any tank is that which will result in a 55 percent load factor or 400-hr use per month. After a few months' run, the elements can be changed if necessary to give the desired load factor. This 55 percent load factor was chosen in preference to a higher one to allow for time-switching the load off the daily peak when and if that was deemed necessary or advantageous to the utility company.

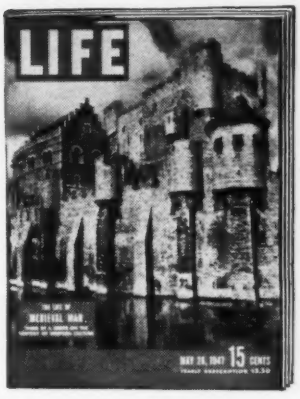
Tank Installation

The tank is installed either as a series or circulator in conjunction with the storage tank of the existing heating system in a smaller apartment building. For a large user two tanks have been installed in parallel for greater capacity, as in a busy restaurant. When used in conjunction with a fuel-fired existing hot water system the consumption is high in summer and low in winter when the heating boiler is supplying the hot water. This gives the utility welcome summer load. If desired, induce-

CAMPAIGN

that will be building sales for you this Fall!

LEADING NATIONAL MEDIA!



13 INSERTIONS IN THE FIFTEEN WEEKS OF THE FALL BUYING SEASON!

Westinghouse lamp ads in full color will be blanketing the market. Watch for the first ad in "This Week" on September 14th and the full-color spread in "Time" on September 15th—and all the other ads week after week after that.

RAILROAD STATION DISPLAYS IN TEN LEADING CITIES!

A new natural medium for lamps! Will reach a circulation of close to 200,000,000 a year through three-dimensional displays in leading stations of the country.

TED MALONE ON ABC!

A lamp commercial every day Monday through Friday over the 197 stations of the ABC—reaches more than 3,000,000 different people every week.

AND COMPLETE SUPPORT AT THE POINT OF SALE!

Westinghouse—with a *complete* line of merchandisers—provides exactly the right kind of merchandisers for every store. A full selection of new displays ties in with the national advertising.

WESTINGHOUSE ELECTRIC CORPORATION

BLOOMFIELD, N. J.

BERMICO*
FIBRE CONDUIT

FOR SUREST CABLE PROTECTION - - - SPECIFY BERMICO CONDUIT

1 **LIGHT.** Easily handled on the job; one man can carry several 8-foot lengths at once—lay more per working hour.

2 **TIGHT.** All joints are precision milled for tight, speedy, installations.

3 **STRONG.** Bermico Conduit is engineered to take the shocks and stresses of transport . . . the heavy loads imposed during installation.

4 **NO SPLIT COUPLINGS.** With Bermico's specially designed couplings, you end the expense—the loss of time required to replace broken couplings.

5 **WATER PROOF.** Bermico's water absorption factor is extremely low—its insulation factor extremely high, even under toughest conditions.

6 **ACID RESISTANT.** Resistant to soil acids and alkalies, Bermico Conduit is, itself, chemically inert.

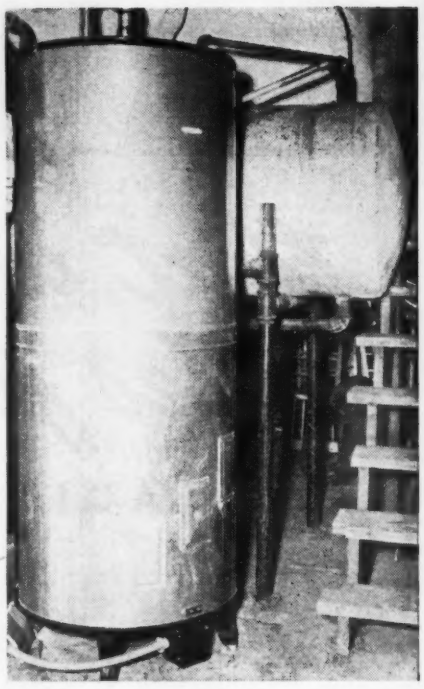
7 **SMOOTH INSIDE BORE.** Quick and easy cable "pull throughs"—without danger of abrasions—when you're using Bermico *inspected* conduit!

8 **UNIFORM.** Four rigid factory inspections guarantee Bermico's uniformity of dimensions, specifications and quality.

distributed by
WESTINGHOUSE ELECTRIC SUPPLY COMPANY
Offices in all leading cities

*Reg. Trade Mark

BERMICO FIBRE CONDUIT—A PRODUCT OF BROWN COMPANY



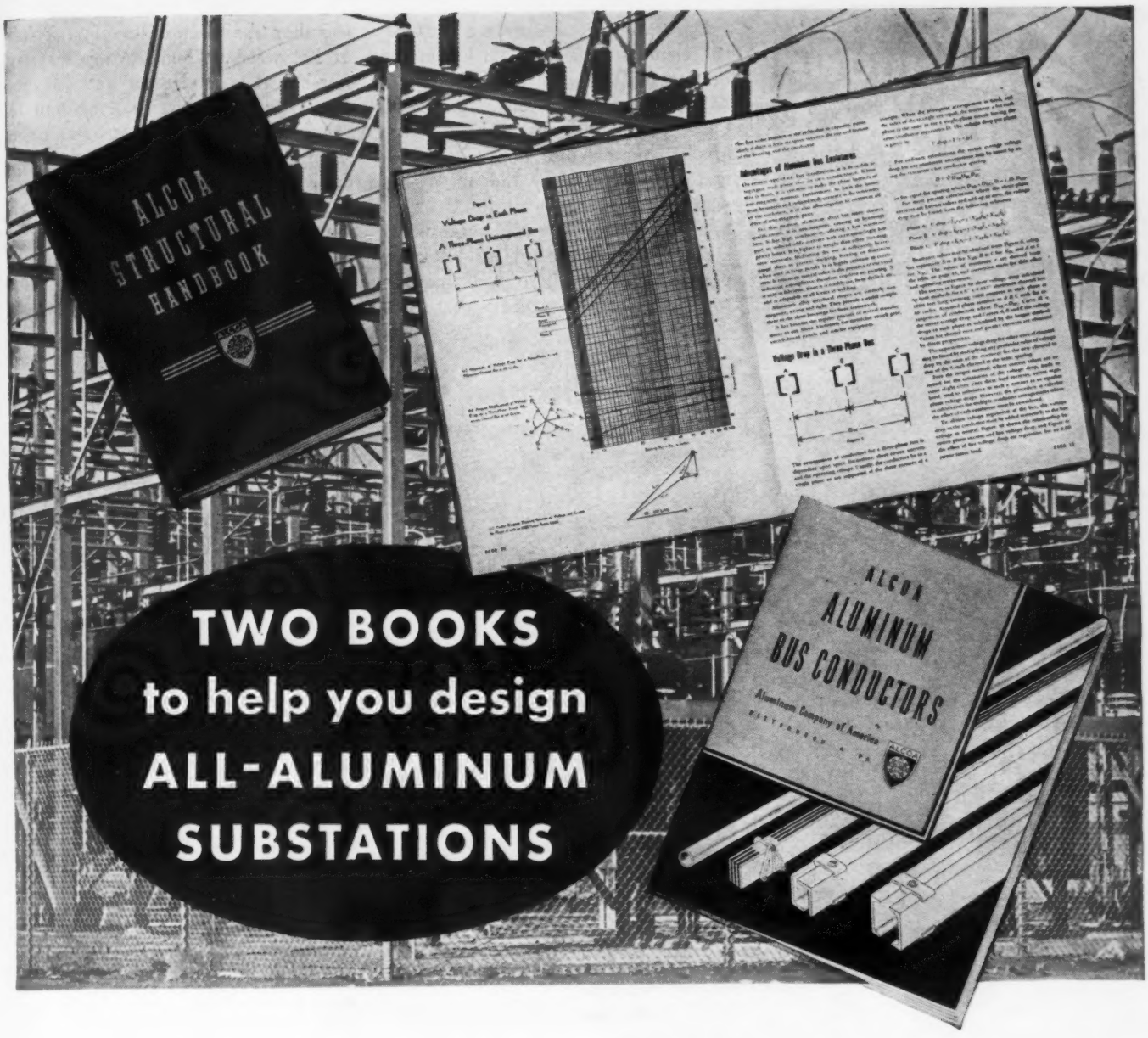
HOT WATER TANK of 100-gal commercial type is connected in series with existing system. House-heating system did not supply sufficient hot water during winter. Electric booster has 5 kw in thermostatically controlled elements in bottom of tank. Average demand is 4.86 kw. Ten apartments with 20 people require 2,760 kwhr per month in summer; a load factor of 79 percent. 1,800 kwhr per month are used in winter at load factor of 52 percent.

ments may be made so that the customer will cut the water heating load off entirely during the winter months.

The system load curve is high in the winter when river flow is minimum and drops off in spring and summer when the flow is maximum for the hydro systems in the Pacific Northwest. Water heating in this manner is the only apparent summer load that can be developed. Cool summers and rain eliminate air conditioning and irrigation as summer loads.

Heating elements and thermostats in these tanks are placed as near the bottom as practicable. Three thermostats and six heater wells are provided. Recuperation or recovery is no consideration beyond the 55 percent load factor desired. While all installations so far have been entirely satisfactory, should a consumer run out of hot water frequently, his storage-wattage ratio would be regarded as too low and an additional tank provided, with the same wattage.

Placing all heating elements in the bottom of the tank may seem contrary to the trend of two-unit heaters, but that is the only way to take full advantage of the capacity of the tank.



When you design your next substation, make it *all-aluminum*. Be sure you have the books to do the job . . . "Alcoa Aluminum Bus Conductors" and "Alcoa Structural Handbook". Ask our nearest sales office about getting them for you.

Alcoa Aluminum strong alloy structural shapes form the supporting members for the current-carrying Alcoa Aluminum Bus Conductors in an all-aluminum substation.

Neither the supports nor the bus members require painting . . . you avoid the cost and hazard of this operation.

Alcoa Aluminum Bus Conductors are light, have high electrical efficiency, are easy to form and assemble. You have your choice of round or square tubing, flat bars, channels, and angles. Also, there are Alcoa-engineered fittings to make joints, angles, and tap-offs.

Our literature and our 59 years of aluminum know-how are at your service. ALUMINUM COMPANY OF AMERICA, 2138 Gulf Building, Pittsburgh 19, Penna. Sales offices in leading cities.

MORE people want MORE aluminum for MORE uses than ever

ALCOA FIRST IN ALUMINUM

IN EVERY COMMERCIAL FORM

Sell more Light! with *COLOVOLT

Cold Cathode Lighting Equipment

Ravizza Supermarket, West Hartford, Conn.

Only Colovolt cold cathode, low voltage, ballast-type fluorescent lighting equipment can offer you all these extra advantages in good lighting.

- Lamp life rated at 10,000 hours
- Lamps guaranteed for one year
- Instant starting
- No blinking or flicker
- No starters or moving parts
- Lower maintenance cost

SEE OUR CATALOG IN SWEET'S

Architectural & Engineering Files for 1947.

Write for Cold Cathode lighting information for Lighting Salesmen, Contractors, Architects and Engineers.

*Trade Mark Registered U. S. Pat. Off.

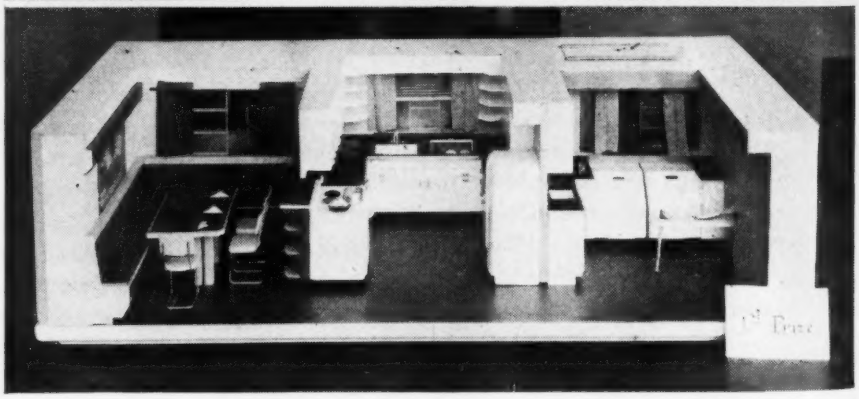
GENERAL LUMINESCENT CORP.

680 S. FEDERAL STREET • CHICAGO 5, ILLINOIS

For example, a standard 100-gal, two-element tank with 2.5 kw in the bottom and 5 kw about one quarter down from the top, consuming 2,500 kwhr per month in a drug store lunch counter did not give satisfactory service. They ran out of hot water and had to wait for over an hour for more. It would require 3.5 kw continuously to supply 2,500 kwhr per month. The mere fact that the top element was on means there was less than the top quarter of tank full of hot water. When the top quarter was hot, the top element went off and the lower 2.5 kw was not enough to carry the load. This store was open from 8:00 am to 1:00 am the next day, then scrubbed after 1:00 am. A 100-gal commercial tank with 5 kw in the bottom was installed and gave full satisfaction to the customer and represented one-third less demand for the same consumption.

• • •

Model Kitchen Contest Creates Interest



ADVANTAGES OF ELECTRIC KITCHENS were emphasized at Hartford, Conn., in a recent contest sponsored by the American Refrigeration Co. Models of up-to-date kitchens were completed by twelve members of the industrial arts class led by Alvin Reinhart at the Hall High School, West Hartford. The winning model was displayed in the Hartford Electric Light Co's main office. About two months were devoted to the model construction during the school year, none of such type having been built by any of the contestants previously. Equipment was modeled in wood and the layout of the winning display featured a breakfast nook, range, refrigeration and sink section, and laundry with miniature electric iron and simulated outlet. Much public interest was shown in the display at the utility's office. In the top picture Arthur Warner, president, American Refrigeration Service, West Hartford, presents the first prize, a Casco Electri-Craft set, to Valon Patton, aged 17; below appears the model which won top honors, its scale ¼ in. per ft

Men working together, for production, can give America what it needs: more and finer products ...greater *values* ... better standards of living... for all! Slow-downs or forced idleness deprive everyone of the gains industry can offer only through more production.

Only through cooperation for production can America benefit by the great technological advances of recent years. Modern MOSINEE papers, for instance, custom-made to meet specific requirements, are helping to improve products, slash costs, raise standards of living.

MOSINEE paper technicians are equipped to create paper with scientifically controlled chemical and physical characteristics to improve many products and processes. Call MOSINEE!

MOSINEE PAPER MILLS CO. MOSINEE, WISCONSIN

MOSINEE PAPER MILLS COMPANY

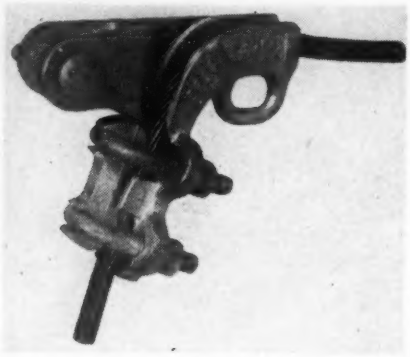
MOSINEE • WISCONSIN

Essential Paper Makers

Please address your letter to Attention Dept. B

NEW EQUIPMENT

Line Clamps



A NEW LINE of bronze and aluminum strain type and suspension type clamps has been designed by Electric Fittings Foundry, P. O. Box 370, Birmingham, Ala. The two-types are reported to be 20 percent stronger than maximum size cable. The bronze clamps are used on copper cables and aluminum clamps on aluminum lines.

Advantage claimed is that the bronze on copper and aluminum on aluminum does not cause electrolysis and corrosion that is present where iron or steel clamps are used. Use of the new clamps makes it unnecessary to use copper or aluminum sheet liners in the clamps. Since both types of clamps are nonmagnetic, hystersis and eddy currents are not present and there is no danger of annealing when the line is loaded.

The clamps are in the bright raw state of metal and are said to remain so with use. They have been designed for light weight by using narrow keeper guides instead of large flanges. Another feature is the use of "U" bolts and pins which are electro-galvanized and do not touch the cable. All clamps are interchangeable with other line materials and are tested in the company's laboratories. Designs carry a variety of cable sizes, thus reducing the amount of stock carried.

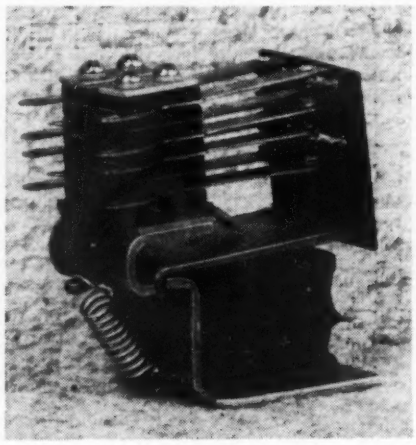
•

Electronic pH Meter

A NEW pH meter for laboratory and industrial applications and for various types and designs of electrodes has been introduced by Photovolt Corp, 95 Madison Ave, New York 16, N. Y. The meter is stated to cover the complete pH range and has a 7-in. scale and mirror. The dial has an additional scale from minus 400 to plus 400 mv. The instrument is furnished with a shielded glass electrode and is standardized with a single buffer solution and a single control knob. It is designed to operate on 50-60-cycle circuits. A voltage selector is provided to make it usable on any voltage between 90 and 275. All electronic tubes and calibrating control are accessible from the rear of the housing.

•

Appliance Control Relay

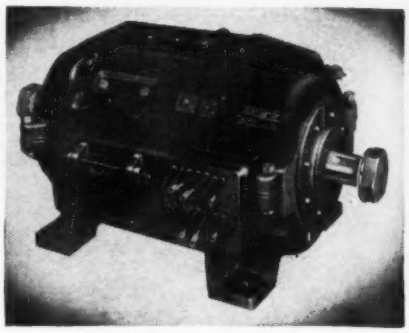


A NEW multi-contact a-c relay designed specifically for appliances and vending machines has been announced by the Control Division of the General Electric Co, Schenectady, N. Y. Featuring quiet operation and compactness, the new relay is available in ratings of 5 amp, 115 v, a-c, or 5 amp, 24 v, a-c.

This two-circit relay occupies only 3 cu in. A rocker bearing and contact pressure minimize the effects of dust and fatigue. All ferrous parts are protected from corrosion. A multiplicity of relay forms can be obtained through combinations of contacts.

Molded phenolic insulators have stable dielectric strength and provide $\frac{1}{16}$-in. creepage between adjacent contact springs, as well as ample insulation to ground. The relay mounts conveniently by any two of the four tapped holes in the base. Soldered connections are readily made to the coil and contact terminals.

New Mill Motors



A NEW LINE of mill motors reduced one frame size is announced by Westinghouse Electric Corp, Buffalo 5, N. Y. A larger and more efficient armature that fits within the limiting dimensions of the motor frame, new roller bearings and bearing housing, and redesigned field coils make the new motor possible.

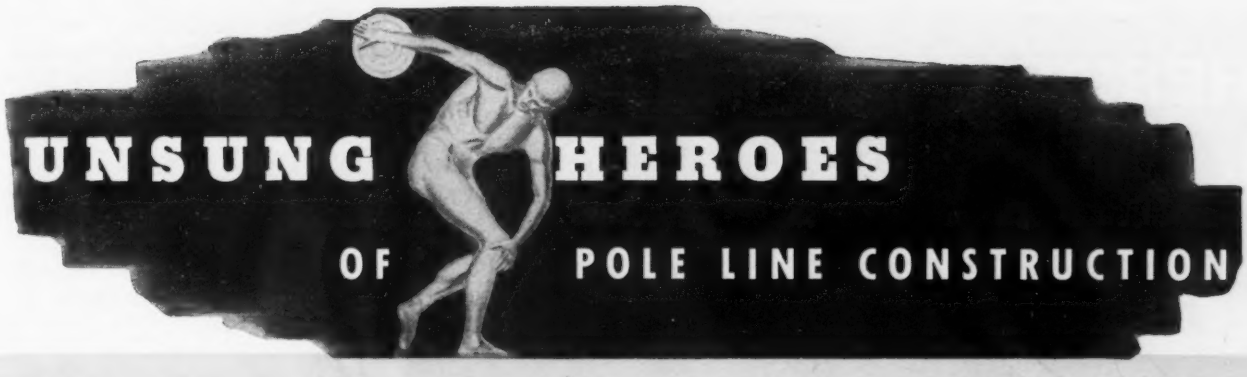
The heavy-duty type MC mill motor is available in totally enclosed, protected self-ventilated or protected force-ventilated construction. It is built in accordance with the AISE standardized dimensions and incorporates the following features: Split frame of cast steel; silicone insulated armature coil conductors; wedges of Class B material to hold coils in slots; new roller bearing and bearing housing that eliminates need of thrust washer and collars; improved field coil insulation; and rigid mounting of brush holders. It is available in sizes from 5 to 200 hp; in voltages of 230 and 550; and in AISE dimension frames 602 to 618.

•

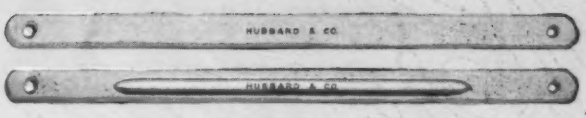
Solderless Connectors

OVER 30 different types of O.Z. solderless connectors, designed for wire sizes from No. 12 to 2,000,000 cir mils, are now offered with a special "Cadux" plating which makes them suitable for aluminum building wire connections, according to an announcement made by the O.Z. Electrical Manufacturing Co, Brooklyn, N. Y.

These new Cadux-plated connectors are said to assure positive, permanent connections on aluminum. The Cadux plating is reported to eliminate the normal electrolytic action which usu



Simple things, CROSS ARM BRACES, just a strip of flat steel with a hole punched in each end, but most important to a pole line. Hubbard Braces are fabricated from the best, new, open-hearth steel and all corners are rounded to protect linemen from sharp projections. For the engineer who wishes additional strength on the compression side of the arm, the ribbed brace is provided and offers approximately 25% added protection.

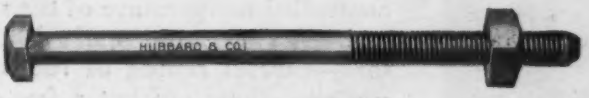


HUBBARD FLAT AND RIBBED
CROSS ARM BRACES

HUBBARD ANGLE CROSS ARM BRACES, for heavy construction, are supplied in a range of spreads and drops to meet the requirements of any standard construction. Angle size runs from 1½ to 2-inches. At the pole attachment hole, the angle is so formed that wrench clearance is provided. Attachment is by ⅝-inch Machine Bolt at the pole and ½-inch Carriage Bolts at the arm.

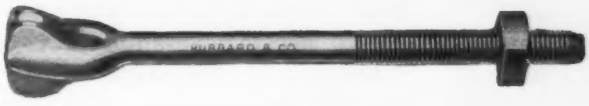
HUBBARD ANGLE CROSS ARM BRACE

DRIVE POINT MACHINE OR CROSS ARM BOLTS are roll-threaded to provide a "finger-fit" for the full length of the thread. The "Drive Point" feature enables the bolt to be used as a drift pin for the alignment of holes slightly off center. This operation must be carried out with caution so as not to injure the threads. "Drive Point" also facilitates the application of nuts and allows bolts to be driven out of the pole for reclamation without injury to the threaded end. The major portion of Hubbard bolts of all types have this feature.



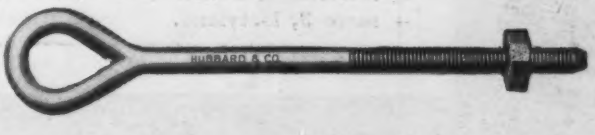
HUBBARD DRIVE-POINT
CROSS ARM OR MACHINE BOLT

HUBEYE BOLTS are furnished for attachments of any kind where a thimble would normally be used. The eye of the bolt is drop-forged to a shape which provides a perfect "built in" thimble. Strand may be looped around the Hubeye with complete protection. Side walls of the eye retain the roundness of the strand. There is no possibility of kinks or strains at the loop. Hubeyes are a thoroughly tried and proven product.



HUBEYE DRIVE-POINT BOLT

STANDARD HUBBARD OVAL-EYE BOLTS are an old line item still much used in many sections. Hubbard Eye Bolts are all drop-forged with an eye that is stronger than the shaft of the bolt. Made from the best, new, open-hearth steel and Hubbard Double-Dip Hot Galvanized.



HUBBARD OVAL-EYE
DRIVE-POINT BOLT

HUBBARD AND COMPANY

PITTSBURGH CHICAGO OAKLAND CALIF.

HERE'S WHY WE KEEP SAYING..

"Permazinc"

...and not just galvanized

Permazinc, — Locke's *Quality Controlled* double hot-dip galvanizing — is an alloy-bonded protective coating that is actually a part of the steel.

Thorough cleaning to remove all foreign materials—proper drying—automatically controlled temperature of the molten zinc baths—experienced and skillful operators—careful setting of the molten zinc surface—these are but a few of the reasons why *Permazinced* Locke pole line hardware gives you added years of dependable performance.

For years *Permazinc* on Locke suspension and switch insulators has been a standard of comparison to operating men. Get this same dependability in pole line hardware by specifying Locke.

The ***Permazinc*** process is more fully described and illustrated in a folder recently issued. Get your copy by addressing a card or letter to Locke Insulator Corporation, Advertising Division, P. O. Box 57, Baltimore 3, Maryland.

Locke POLE LINE HARDWARE and INSULATORS

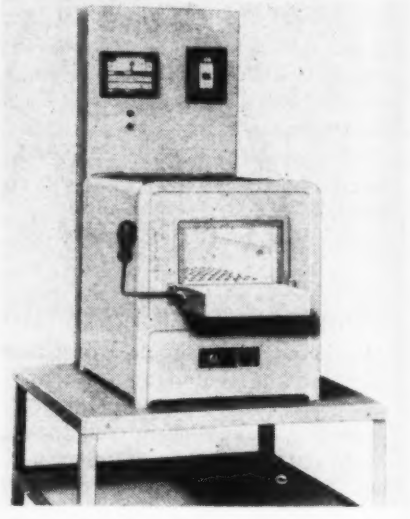
LOCKE INSULATOR CORPORATION • BALTIMORE 3, MD.

ally takes place between copper and aluminum. Heretofore, Cadux plating has been widely used in the protection of non-ferrous metals from surface tarnish and corrosion.

•

Air-Draw Furnace

TWO NEW FURNACES of the recirculating air-draw type have been added to the line of small electric box furnaces



developed by Cooley Electric Manufacturing Corp, Indianapolis, Ind. Model ACL is designed for temperatures to 900 F, and Model ACH for operation to 1,200 F. Chamber size is 10 in. wide, 6 in. high and 14 in. deep. Either furnace will handle 50 lb of small parts. Power input of both furnaces is 4 kw at 230 v.

Embedded heating elements are located behind vertical baffles at either side of the chamber. An impeller-type fan below the perforated hearth plate forces air up between the baffles and heating units. Air then circulates down through the work and back to the fan. The fan is driven through a V-belt by a 1/6- to 1/4-hp motor located at rear of the furnace.

Temperature uniformity of plus 5, minus 0 deg is claimed. Control is effected by a selective power modifier operating with an indicating pyrometer.

•

Classroom Fixture

A NEWLY DESIGNED fluorescent unit known as the Schoolmaster built for use in classrooms has been announced by Leader Electric Co, 6127 Broadway, Chicago 40, Ill.

With the correct 60 percent downward and 40 percent upward light diffusion for schoolroom use, the unit features a new application of a built-in germicidal lamp which is not visible if

UNITED STATES RUBBER COMPANY

SERVING THROUGH SCIENCE

They said it couldn't be done!

Quite a few people didn't believe a natural rubber-covered building wire could have the smallest diameter in the business and *at the same time* have no equal in physical and electrical properties.

But that was before U. S. Rubber Company scientists produced Laytex (Type RU). Today, Laytex is the wire man's delight. Its small diameter permits more circuits per conduit. By means of a special dip process, Laytex is insulated with 90% unmilled grainless natural rubber. The conductors are perfectly centered in this insulation, thereby avoiding any chance of thin spots.

Laytex (Type RU) is lighter in weight, easier to install. The saturated cotton fibrous cover is flame-retardant and moisture-resistant.

UNITED STATES RUBBER COMPANY
1230 Avenue of the Americas • Rockefeller Center • New York 20, N. Y.

Specify RU **Laytex*** **ELECTRICAL WIRES AND CABLES**

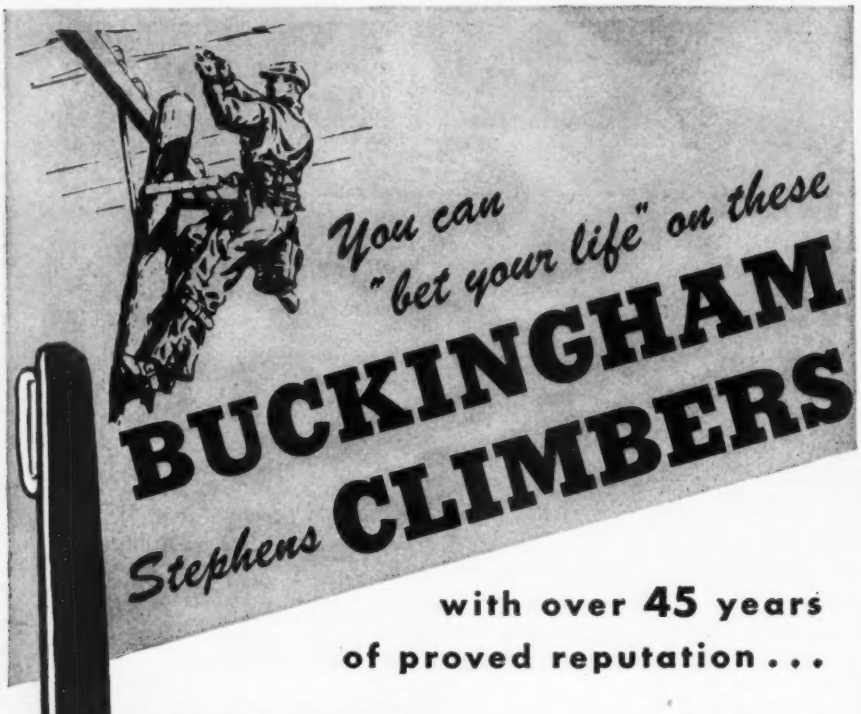
SAFETY FACTORS THAT PUT *RU* OUT IN FRONT

BULL'S EYE
The conductor is on dead center throughout every inch of the wire.

ELEPHANT INSULATION
Laminated walls of tough natural rubber insulation mean Laytex is safe.

SMALLER O.D.
Allows more circuits per conduit than in ordinary wire. Lighter weight.

*Reg. U. S. Pat. Off.



You can "bet your life" on these

Stephens BUCKINGHAM CLIMBERS

with over 45 years of proved reputation . . .

FOR QUALITY Superior workmanship, advanced design, and the finest materials are combined to give these famous Stephens Climbers a margin of quality unmatched for nearly half a century.

FOR SAFETY These rugged climbers are designed and tested with one principle in mind — *safety for the lineman!* Drop impact tests, magniflux tests, Rockwell tests, detailed final inspections . . . all give that *extra margin* that distinguishes *Buckingham safety.*

FOR COMFORT Here's why Buckingham Climbers are more comfortable, less fatiguing to the lineman . . .

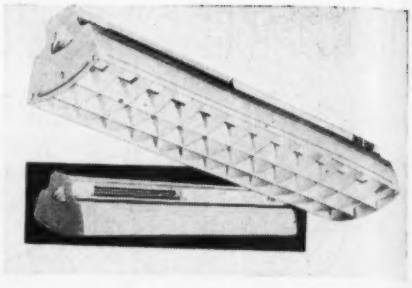
- Shank gives a perfect leg fit. Climbers in all sizes, 14" to 20".
- Wide standing surface is slightly rounded to fit the foot.
- Round loop will not cut the straps.
- Gaff is hammer-forged from special tool steel, and properly located to support the foot of the lineman, causing less strain in climbing, maximum comfort in standing.

FOR DURABILITY The best materials plus high standards of experienced workmanship give these climbers a durability that guarantees years and years of heavy duty, rugged service.

Three different weights: Medium, light, feather. Straight and offset.

SEE YOUR DISTRIBUTOR
Now more than 400 outlets handling Buckingham Equipment.

BUCKINGHAM MANUFACTURING CO., INC.
Walter E. Craw, Pres. 5-7 Travis St., Binghamton, N. Y.

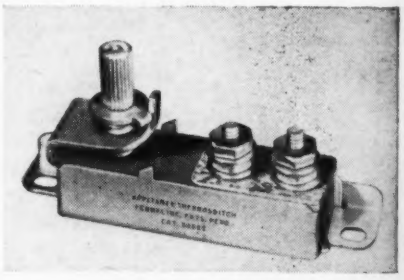


the fixture is hung at ordinary lighting levels. The visual cut-off angle of 90 deg is provided by an Alzac parabolical reflector, with the reflected cut-off angle 90 deg. Fixture is so designed that the heat of the ballast causes circulation of air in the room to pass over the germicidal lamp. Other features include a free-swinging louver for easy maintenance and a couple button for simple continuous row mounting.

•

Appliance Thermostat

A RECENTLY DEVELOPED heat control unit has been designed to control temperatures in flat-surface applications,



including: Flatirons, automatic ironers, waffle irons, sterilizers, pasteurizers, dairy water heaters and hot plates. Known as the Thermoswitch, it is a product of Fenwal, Inc, 31 Pleasant St, Ashland, Mass. The temperature adjusting screw is claimed not to drift under normal vibration.

One model provides control over the range of 175 to 600 F; another model has a range of 50 to 250 F. Over-all case dimensions are ½ in. high, ⅝ in. wide and 2⅛ in. long. Mounting bracket provides for side or bottom mounting. Maximum load rating is 1,200 watts on 110-v, 60-cycle circuit.

•

Cable Connectors

NON-METALLIC cable connectors for commercial and residential wiring, announced by Tomic Sales and Engineering Co, of Detroit, are newly designed devices said to cut labor costs and to allow ample working space within the knock-out box.

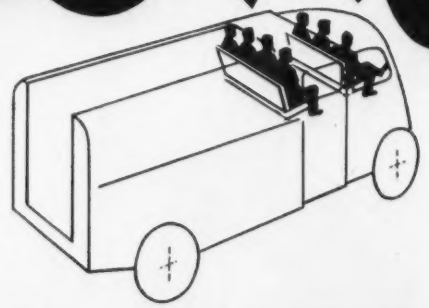
In contrast with old techniques for connecting cables, there are no locknuts

Series 600 C Line Construction
& Maintenance Body

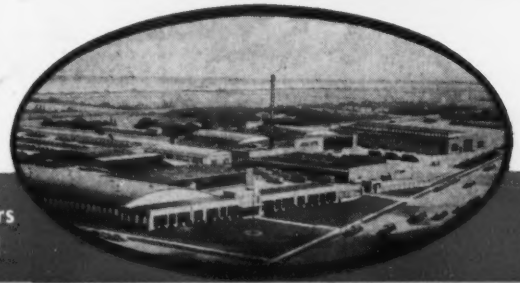
ALL-STEEL

POWERS

PUBLIC UTILITY BODIES



TOWN or COUNTRY
Line Construction and Maintenance Service



Over 75 years experience!

LINE BODIES • SERVICE BODIES • POLE TRAILERS • SPECIAL EQUIPMENT

McCABE-POWERS AUTO BODY CO., 5900 N. BROADWAY, ST. LOUIS 15, MO.

300 Guernseys and he's his own cow-hand...

Talk about riding herd—the owner of this farm can do it from his backyard. He depends on an electric cow-hand.

Charged fences keep many herds in pasture—just one example of how electrification has helped streamline farm work—save time and labor.

Power for many of these modern farms is carried on pole-lines equipped with Owens-Illinois Power Insulators. These glass insulators for electrical distribution systems are made under the most carefully controlled conditions by a pioneer company in the glass insulator field.

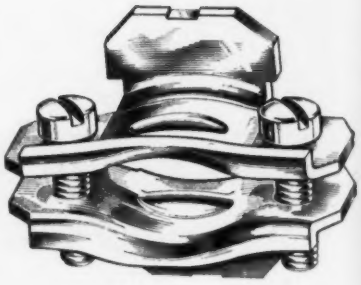
Principal jobbers carry stocks of Owens-Illinois Power Insulators and are making prompt shipments.

•

Every lot of Owens-Illinois Power Insulators is tested under methods set by American Institute of Electrical Engineers in specifications No. 41-1944 (ASA C 29-1944) and by the American Society for Testing Materials D-730-43T.

OWENS-ILLINOIS POWER INSULATORS

Owens-Illinois Glass Company, Hemingray Division, Muncie, Indiana



that must be removed and replaced. Through the use of the Tomic nonmetallic cable connector, which fits in from the outside on all standard knockout boxes, the cable is merely slipped through and kept in position with two tightening screws and an exclusive locking feature. It may be used on both old and new type sheathed cable, and is available in ¾-in. and a ½-in. size.

•

Aluminum Ladder

A NEW featherweight model aluminum ladder weighing slightly over 1 lb per ft and stated to be safe for a 250-lb load is obtainable from Aluminum Ladder Co, Carbis St, Worthington, Pa. Designated as Model DLL, the ladder has corrugated rungs. Sizes range from 6-ft to 16-ft lengths and two of the 8, 10 and 12-ft lengths can be joined to form an extension ladder.

•

Precision Switch

A PRECISION SWITCH, featured as a sealed unit and designated type N2 die-cast enclosed switch, is announced by Micro Switch Corp, Freeport, Ill. It is designed for cam and slide actuation on industrial applications where there is exposure to dust, dirt, abrasives, and the occasional splash of oil and water. The roller arm actuator is adjustable both vertically and horizontally.

Synthetic rubber boot covering the

TRUMBULL ELECTRIC

MD-5

MANUAL REVERSING STARTER

- A SAFE, *manual reversing controller* that eliminates confusion where reversal is non-automatic.
- A SIMPLE, inexpensive way to provide reversing feature in combination with magnetic operation.
- Compact tumbler type . . . double throw . . . locks in either position.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY

PLAINVILLE, CONNECTICUT

OTHER FACTORIES AT NORWOOD, OHIO • SAN FRANCISCO • SEATTLE • NORTH HOLLYWOOD

CRESCENT SERVICE CABLES

Employ

ENDURITE

Heat Resisting Insulation

● CRESCENT Service Cables, Sizes No. 6 AWG and larger, are insulated with a Type RH, Crescent ENDURITE super-aging, heat resisting rubber compound of the best grade obtainable that gives *20% greater current carrying capacity* than ordinary code grade insulated service cable.

● Service cable is the bottleneck limiting the amount of customer demand for all appliances, and future business for the contractors, dealers, wholesalers and power suppliers.

● With CRESCENT SERVICE CABLE you get maximum load capacity, long life and value. Made in Type SE, Style U, as shown; Style A with a galvanized steel armor tape over the bare neutral conductor, and in Type SD, Drop Cable, Sizes —#12 to #2 AWG in two and three conductors.

Available Through
Electrical Wholesalers

CRESCENT WIRE & CABLE

CRESCENT INSULATED WIRE & CABLE CO.
TRENTON, N J

operating plunger and the gasket assembled between the bottom plate and the housing case is reported to provide a completely sealed switch unit, when the conduit hub is fitted with rigid conduit.

The switch is supplied with either bottom mounting or side mounting facility. Capacity is 10 amp 125 volts, 5 amp 250 volts, 3 amp 460 volts a-c. Operating force is 6 to 16 oz; release force 4 oz max; pre-travel $\frac{1}{64}$ in. max; overtravel $\frac{3}{32}$ in. min; movement differential 0.006 in. max. Net weight is 0.64 lb.

•

Low Voltage Tetrode

AVAILABILITY of a small 65-watt, radiation-cooled electronic tube has been announced by Eitel-McCullough,

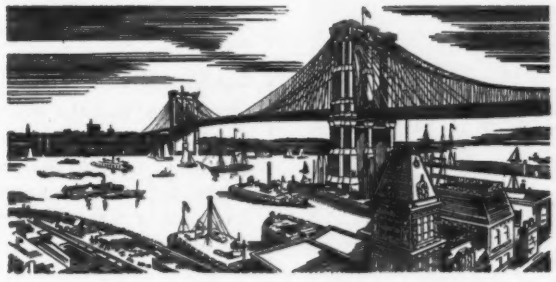
Inc, 178 San Mateo Ave, San Bruno, Calif. Designated type 4-65A, the tetrode is designed to fit commercially available sockets and is stated to be suitable for mobile applications. It features an instant-heating, 6-volt, thoriated tungsten filament, non-emitting grids, and a processed metal plate, all enclosed in a hard glass envelope. Rated plate voltage range is 400 to 3,000 volts. In typical operation at a plate voltage of 400 volts and 0.1 amp of plate current, a power output of 28 watts is obtained with less than 2 watts of grid driving power; operating at 2,000 plate volts, power output provided is 200 watts.

•

Display Lighting Unit

UTILITE No. 1 is a new display lighting unit for store, window and display area illumination recently added to the line by Steber Manufacturing Co, Broadview, Ill. The holder of this unit, which is adapted for both indoor and

.....how much is it worth?



IT WAS NINE YEARS before the first gasoline-driven automobile in the United States was operated by C. E. Duryea that the Brooklyn Bridge was opened in 1883. This fabulous engineering achievement was the culmination of over 26 years of planning and building, of bold vision and heart-breaking struggle, by John A. Roebling and his son Washington.

But the steadfast confidence of father and son in the success of their amazing venture is vindicated daily by the modern traffic this world-famous bridge continues to carry now . . . 64 years later.

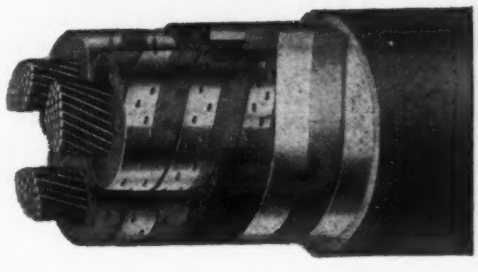
How much is that confidence worth to you today . . . and to the John A. Roebling's Sons Company, now embarked on a multi-million dollar expansion program to meet the future's challenge?

Confidence is the driving power behind our efforts to make better products do better work for you.

FOR SIMPLER INSTALLATION AND MAINTENANCE
—Roebling Paper Insulated Cables

Keep this in mind when you specify power cables: the modern "solid" type underground cable provides a simplicity of installation, an ease in maintenance care that you'll find in no other cable types designed for the same purpose.

An example is Roebling Impregnated Paper Insulated Cable, of which the Shielded Type H illustrated is especially favored for 3-Phase grounded neutral circuits at from 13 to 33 kv. Low ionization, elimination of dangerous tangential stresses, increased current carrying capacity, simplified protective devices, and smaller over-all diameter for a given voltage...these are some advantages of the shielded construction in this "solid" type typically dependable Roebling cable.



The new Roebling book "Electrical Wires and Cables" is filled with facts, figures and features on construction of wire and cable. Send for your free copy today.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

Electrical Wire and Cable • Suspension Bridges and Cables
Aircord, Aircord Terminals and Air Controls • Lawn Mowers

ROEBLING

A CENTURY OF CONFIDENCE

THE SMALL EXTINGUISHER..

WITH THE *MIGHTY PUNCH!*

FOR FIRE HAZARDS THAT DO NOT DEMAND LARGER EQUIPMENT . . .

The new ANSUL 4 Dry Chemical Fire Extinguisher has fire stopping effectiveness far in excess of any other extinguisher of comparable size. Its compact size makes it ideal for locations where space is limited. The ANSUL 4 is easy to use . . . easy to recharge on-the-spot . . . and again ready to

STOP FIRE FASTER!

MADE BY THE MAKERS OF ANSUL-DUGAS DRY CHEMICAL FIRE EXTINGUISHERS, MODELS 20, 30, 150A AND 350A.

ANSUL CHEMICAL COMPANY
FIRE EXTINGUISHER DIVISION, MARINETTE, WISCONSIN

outdoor service, is an aluminum casting finned to radiate the heat generated by projector or reflector lamps. A gasket of flexible Neoprene is fitted permanently into the mouth of the holder to make a water-tight connection. The base has rubber bumpers which may be removed when the unit is mounted permanently. Adjustments of 360 deg horizontally and 180 deg vertically are secured in fixed position by a hand-operated set screw.

•

Aluminum Duct Rod

A NEW duct rod made of aluminum is being introduced by Abbott & Matthewson, Inc, Buffalo, N. Y. Advantages reported are freedom from rust, reduced weight (about 1 lb for each 3-ft length), and ease of cleaning (by hosing).

The rods have no male or female joints, each coupler being identical. The rod can be picked up by either end and added to the line—a single turn couples or uncouples each section. The coupler is so designed that its swivel action allows rodding of any standard reverse curve in reinforcing conduit runs. A simple curve of 30-in. radius is said to be rodded with ease.

•

Flashlight

APPROVED by Underwriters Laboratories, Inc, for Class 1, Group D hazardous locations, two-cell and three-

WHY QUALITY CONTROL MAKES RoZone THE SUPERIOR OZONE RESISTING INSULATION

5000-Volt Power Distribution Cable.
500,000 CM stranded conductor, RoZone insulation, with RoPrene (Neoprene) sheath.

The answer lies in the fact that at Rome Cable quality control is positive . . . is in the hands of a group long experienced in wire and cable manufacture. With research and development, product engineering and inspection effectually coordinated under the same *single* executive supervision, the result is threefold unity of function . . . development of quality . . . design of quality . . . *control* of quality.

Detached from sales or production pressures, it is this group's job to see that top quality production is maintained at all times . . . and that materials and manufacturing methods are the best possible for the product involved.

RoZone was specifically developed to fill the need for a high quality ozone-resistant rubber insulation for general and high voltage applications. RoZone is recommended for low or high voltage power circuits, series street lighting, motor, generator and transformer leads, portable power circuits, station control and signal service. RoZone insulated cables are manufactured with RoPrene (Neoprene) sheath or other conventional cable coverings as specified. RoZone-RoPrene provides excellent resistance to oils, acids, alkalies, and weather hazards . . . is easy to splice and terminate. It is the natural substitute for heavier, hard-to-get lead sheath.

Ro-Zone has:

1. *Excellent electrical stability in wet locations.*
2. *High degree of heat and oxidation resistance.*
3. *Long life.*
4. *Immunity to effects of corona and ozone.*
5. *High dielectric and surge strength.*
6. *Low dielectric loss.*

Approval and acceptance by leading utilities and industrials

Write for your copy of RoZone Specification Ro-4 *today.*

FROM BAR TO FINISHED WIRE

ROME CABLE CORPORATION

ROME • NEW YORK

• No. 3 of a series on Theory and Application of Electrical Insulation

Familiarity with Breakdown Theories Is

The prevention of dielectric breakdown offers a real challenge to product designers and manufacturers of electrical equipment. Three major theories have been advanced to establish causes responsible for dielectric breakdown. These are the thermal theory, ionic theory and disruptive theory.

THERMAL THEORY

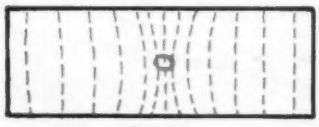


Fig. 1-a

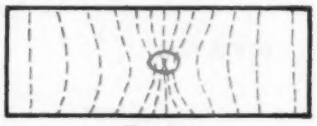


Fig. 1-b

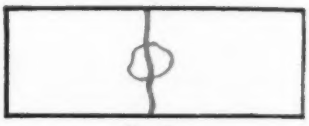


Fig. 1-c

The most generally accepted thermal theory, introduced by Wagner[1], is based on the premise that all solid dielectrics are somewhat heterogeneous. The author points out that some spots, layers, or filaments of dielectrics are lower in resistance than others.

It is his contention, therefore, that the current distribution over a given specimen is not uniform when potential is applied. The weak portion carries more current, energy is released and the spot heated up as indicated in Fig. 1-a. If the insulation or the electrodes are capable of conducting the heat away fast enough, the condition is stable and no failure occurs. But if, on the other hand, the heat is removed too slowly, the weak spots grow hotter and, consequently, lower in resistance, Fig. 1-b, since most materials have a negative temperature coefficient of resistance. This continues until thermal instability results, followed by insulation breakdown (Fig. 1-c).

[1] *"Physical Nature of Breakdown of Solid Dielectrics," A.I.E.E., Vol. 41, 1922.*

IONIC THEORY

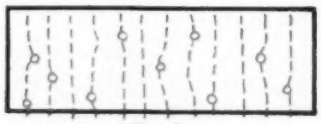


Fig. 2-a

Fig. 2-b

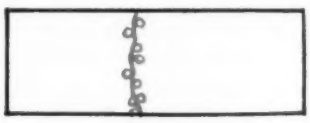


Fig. 2-c

To visualize the ionic theory of insulation breakdown, one can imagine a solid dielectric as an electrolyte in which ions move about to produce a current. This ionization is believed to result from collision or chemical action caused by the field voltage. In either case, as the potential is increased, the fast-moving ions will (1) dissipate energy, and (2) produce other ions. The small circles shown in Fig. 2-a represent regions of local breakdown formed by the dissociation of dielectric molecules. Figure 2-b illustrates that with still higher fields, ions are formed at an increasing rate until instability and eventual insulation failure occur (Fig. 2-c).

DISRUPTIVE THEORY

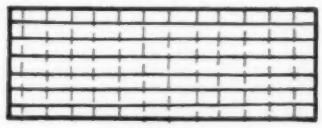


Fig. 3-a

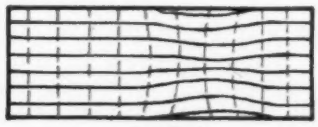


Fig. 3-b

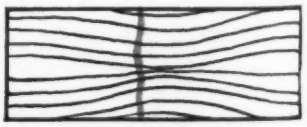


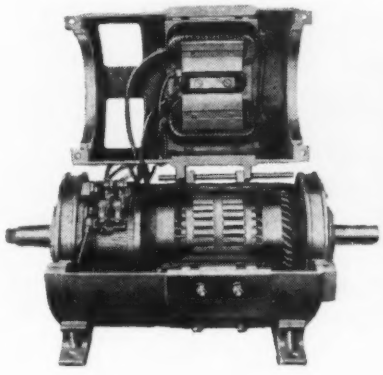
Fig. 3-c

The appeal of the disruptive theory lies in its analogy to mechanical phenomena. We imagine electric breakdown to be a sort of rupture and destruction of molecular and other bonds in the material. Considerable evidence is available to support the disruptive explanation; for example, we know the breakdown of thin specimens and dielectrics at low temperatures cannot be explained by the thermal or ionic theories. The effect of mechanical stress on electrical breakdown gives further support to this theory; investigations have shown that mechanical stresses approaching the elastic limit may reduce the electrical breakdown strength to as little as 10 percent of its normal value. Figures 3-a, 3-b and 3-c show that the lines of electrical force become progressively concentrated on the portion of the dielectric which is under the greatest mechanical stress, thus leading to breakdown.

Helpful in Selecting the Right Dielectric

APPLICATIONS OF DIELECTRIC BREAKDOWN THEORIES

According to the foregoing theories of dielectric breakdown, an insulating material that is to give best service should be, generally speaking, homogeneous in structure, have high physical and dielectric strengths, and be able to withstand high operating temperatures. The insulation used in many household utensil devices and similar electrical heating appliances serves as a fine example of the importance of understanding the theoretical factors affecting insulation behavior.

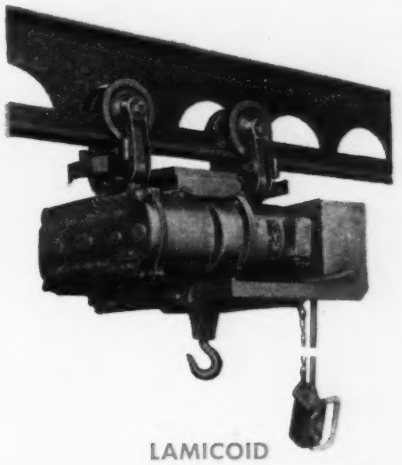


EMPIRE

varnished cloths and tapes, carefully selected to facilitate uniform impregnation, are made from highest quality canvas, duck, silk, rayon and fine cambrics. Special yellow and black varnishes are chosen for their ability to impregnate these materials and to provide a smooth surface. Used widely in armature, stator, field, transformer and regulator coils, terminal leads, high tension cable splices, and busbar insulation.

MICANITE AND SUPER MICANITE

(built-up mica) are made from several different grades of thin mica splittings bonded with various resins. When made with organic bond, which is volatilized during heating, it is popular in electric furnaces and flatirons, where the heating element is never disturbed. Micanite with inorganic binder, which will not burn away, is suitable for unsupported heating elements in toasters, surface heaters and similar products.



LAMICOID

a dense, uniform, thermosetting laminated plastic—is produced with a wide variety of fillers, depending upon the properties desired in the end product. Popular hoist motors, which need added protection from burn-out since they are frequently operated beyond normal capacity, rely on Lamicoid slot sticks in the armature and Lamicoid brush rigging for adequate overload protection and long, trouble-free operation.

Mica Insulator Company offers the electrical industry a single source of supply for a complete line of electrical insulation. The company is also a headquarters for insulation information, based on over 50 years' experience in this field. If you have an insulation problem, consult our technical service department—they will gladly help you select the material best suited to your particular application.

Insulator COMPANY
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ELECTRICAL
INSULATION
Trade mark

DISTRIBUTION ENGINEERS
CUT COSTS!

FOR NEW STREET LIGHTING PROGRAMS
CHECK ADVANTAGES OF

SUNSWITCH
LIGHT CONTROL

✓LOW MAINTENANCE
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ENGINEERED FOR UTILITIES

A rugged unit which automatically switches light "on" and "off" by means of a sensitive photoelectric cell operating entirely according to the footcandle value of daylight.

The SUNSWITCH is fully automatic in operation. Requires no impulses from the power plant or substation.

By use of the SUNSWITCH, street lighting can be operated from secondary circuits. A substantial saving in equipment and operating costs can be realized by elimination of expensive high voltage supply lines and equipment associated with series circuits.

OF INTEREST TO ENGINEERS

Broad operating range. Pole or tower mounting. "SUNSWITCH" operates on 115 or 220 volts, 25 to 60 cycles. Model No. 8239-A operating load on contacts, 3000 watts. Model No. 8239-B, 500 watts.

Improved SUNSWITCH housing and connections permit easy installation with operating parts securely sealed against weather and insects.

CHECK THESE ADVANTAGES

Positive Action • Easy to Install • Long Life • Moisture, Dust and Insect Proof • Pole or Tower Mountings • Low Maintenance Cost • 25 to 60 Cycles—110 or 220 Volt • 500 or 3000 Watt Load.

May we send you full information and specifications? Units are available for testing on your own lighting system.

Ripley

RIPLEY COMPANY, INC.
Exec. & Sales Office: 11 West 42nd Street New York 18, N. Y.
Factory: Middletown, Conn.

cell model flashlights designated Rub-R-Lite "K2" are announced by Lennan Lights, Inc, 231 West Olive Ave, Burbank, Calif.

Claimed to be an innovation in flashlight design, all working parts (including approved bulb-ejector mechanism) are contained in a small "sealed-in-head" unit, which is "popped" in or out of the steel-lined Neoprene case, whenever bulb or batteries are to be changed. The head unit is prefocused. Included is a one-button switch (red rubber button on outside of case) which is pressed for "on" and pressed again for "off."

•

Frozen Food Cabinet

A NEW IDEA in frozen food merchandising makes use of the Frigid-Freeze "Spot Special" cabinet-on-wheels which

has been introduced by Refrigeration Corp of America, 55 West 13th St, New York 11, N. Y.

The portable unit has a capacity of about 250 lb, spaces for approximately 20 doz packaged items. It is 46½ in. long, 29¾ in. wide, 37¾ in. high. The superstructure is 21 in. high. The convenient size makes possible the use of this cabinet-on-wheels in almost any part of the store and it can be kept constantly in the line of traffic flow.

•

Disk Brake

LATEST ADDITION to a line of brakes produced by Stearns Magnetic Mfg Co, Milwaukee 4, Wis., has a maximum torque rating of 2 lb-ft for continuous duty; 3 lb-ft for intermittent duty. The brake is designed for use on ⅙, ¼, ⅓, ½ and ¾-hp a-c motors. It may be motor- or floor-mounted and can be supplied for horizontal or vertical operation.

NEWS ABOUT PEOPLE

Mississippi Power & Light Makes New Assignments

Recent personnel changes in the engineering department of the Mississippi Power & Light Co's headquarters at Jackson have been announced.

Jere F. Harrison, veteran engineering official, was recently named engineering consultant for the company. In almost two decades with the organization, Mr Harrison has played a leading role in the development and progress of the organization, having served as both chief engineer and general superintendent in charge of engineering, operation and construction.

Named chief engineer is J. B. Fountain, an outstanding member of the engineering department for almost 20 years. Ray W. Braswell, formerly operating superintendent, was named operating and engineering manager.

Mr Harrison joined Mississippi

R. W. Braswell

Power & Light Co in 1928 as construction superintendent, after previous experience in utility construction and engineering in the Carolinas, Georgia and Florida. Assuming his duties with Mississippi Power & Light, when its system facilities were in the early stage of development, he pioneered the first system expansion program. In his capacity as engineering consultant in the executive department, he will have responsibilities in the administration of the current $20,000,000 expansion program.

Mr Fountain started with the company in 1928 at Vicksburg as a student engineer and since that time has distinguished himself as he successfully

J. B. Fountain

handled one responsible position after another in MPL engineering operations. Just previous to his last promotion, he had been engineering superintendent of the company in charge of all electrical and civil engineering functions. In his new capacity as chief engineer, his responsibilities will include the planning and designing of all specifications and standards of all electrical physical property of the company, and the overseeing of all major construction projects, engineering surveys, maps, drafting, etc. Mr Fountain is a member of AIEE.

Mr Braswell joined Mississippi Power & Light last year following an association with Louisiana Power & Light Co and assumed the duties of operating superintendent. In his new position, Mr Braswell will be in charge of the operating, engineering, construction and maintenance of all physical property, both electric and gas and in addition will oversee the preparation and control of construction budgets, operating analyses, purchasing, etc.

•

► Dr Bruce S. Old has been appointed consultant to the Atomic Energy Commission, Division of Research, in the capacity of chief metallurgist. Dr Old will continue his present work with Arthur D. Little, Inc, Cambridge, Mass., industrial research laboratory, and will serve the Atomic Energy Commission on a part-time leave of absence from the Arthur D. Little organization. He will assist in organizing the work of the commission in the metallurgical field.

McGraw Electric Assigns Broader Duties to Riker

Appointment of Burton M. Riker as general manager of the Clark Water Heater Division has been announced by the McGraw Electric Co, Chicago.

Mr Riker's experience in the electric water heating industry dates back to its inception as a major load builder in the electric utility field. As commercial and industrial manager for the

B. M. Riker

Rockland Light & Power Co, Nyack, N. Y., he conducted field tests of electric water heaters and was closely associated with this and other national committees of the National Electric Light Association and its successor, the Edison Electric Institute.

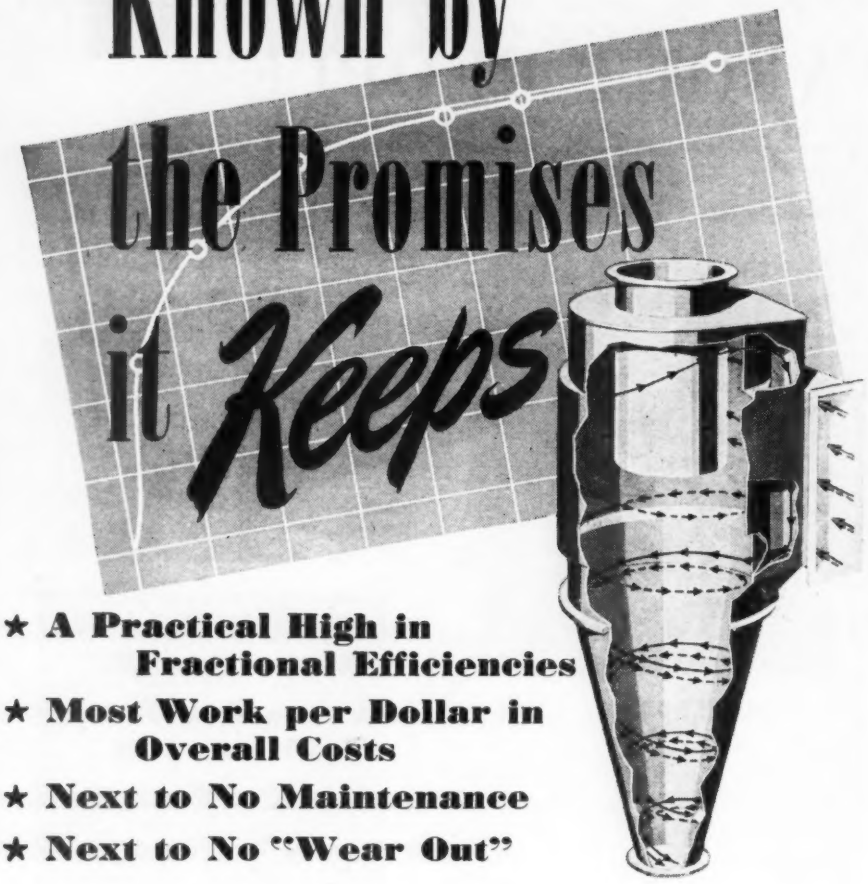
In 1938 he joined the McGraw Electric Co as sales manager of commercial equipment with the Toastmaster Products Division at Elgin, Ill. In 1941 he was appointed assistant to the excutive vice-president.

Mr Riker will continue to serve in this capacity while supervising operations of the Clark Water Heater Division at Chicago, Ill., and Azusa, Calif.

•

► W. P. Venable, power supply superintendent of Consumers Public Power District, Columbus, Neb., has been appointed assistant to General Manager V. M. Johnson. He will have direct jurisdiction over several departments of the district. R. L. Schacht, formerly superintendent of transmission and distribution, has been made general oper-

Known by the Promises it Keeps



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★ **Most Work per Dollar in Overall Costs**

★ **Next to No Maintenance**

★ **Next to No "Wear Out"**

Ten years and more of Buell van Tongeren Cyclone performance in dust control and recovery, in a wide spread of American industries, lays indisputable evidence on the line.

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To every engineer and businessman currently devoting time and thought to a particular problem of dust control or recovery, we offer the Buell fund of practical information. A most useful engineering perspective will be opened up by a study of our new book "Engineered Efficiency in Dust Recovery". A copy is yours for the asking. Write: Buell Engineering Co., 70 Pine Street, Suite 4900, New York 5, N. Y.

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Engineered Efficiency in DUST RECOVERY

ating superintendent. In Lincoln, W. N. JACKSON, superintendent of construction, will be in charge of major construction and transmission engineering and R. J. WOLFE will be superintendent of distribution. J. W. ANDERSEN has been placed in charge of a new industrial and rural development department with headquarters in Columbus.

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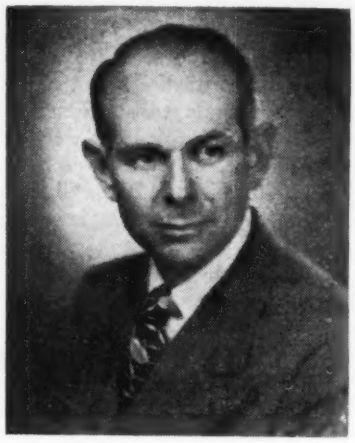
Segall Assumes Executive Duties with Best Electric

B. Z. Segall, formerly connected with New Orleans Public Service, Inc, has been appointed executive vice-president



B. Z. SEGALL

and chief engineer of the Best Electric Co, Inc, New Orleans.

Mr Segall started with New Orleans Public Service 21 years ago in the electric meter department. Up to the time of his resignation he served as an electrical distribution engineer, specifically handling metering, wiring and code problems.

He served as a member of the National Fire Protection Association's electrical committee and has been active in Electrical Code activities.

For the past six years he has been active in committee work for the Edison Electric Institute. He is a charter member of the Louisiana Chapter of the International Association of Electrical Inspectors and at present is serving as the first vice-president of the southern section of the IAEI.

•

► FRANK S. MCNEAL, vice-president and general manager of the Universal Cooler division of International Detrola Corp, Marion, Ohio, has been elected president of the Air Conditioning and Refrigerating Machinery Association.

► WALTER L. STUTZ has retired after 35 years' service at the National Bureau of Standards, Washington, D. C. Mr Stutz

FOR TROUBLE-FREE WIRE PERFORMANCE

125 Permanently Insulated ROCKBESTOS Wires, Cables and Cords

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asbestos and varnished cambric insulated;
For Motor Leads, Control and Power Circuits, Switchboards, etc.
1 4 5
ROCKBESTOS ALL-ASBESTOS
impregnated asbestos and asbestos braid;
For Rheostats, Grid Connections, Power Leads, Furnaces, Apparatus, etc.
4 5
ROCKBESTOS PLAIN ASBESTOS
felted asbestos insulation; various impregnants;
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From the three basic designs illustrated Rockbestos has developed a complete line of 125 failure resisting wires, cables and cords, a few of which are described. All have the same performance guaranteeing characteristics detailed below. Write for information or samples.

Rockbestos Permanent Insulation Insures Long-Lived Service

1. A tough impregnated asbestos braid, resistant to heat, flame, moisture, oil, grease, alkalies and corrosive fumes.
2. Felted asbestos insulation impregnated with heat, flame and moisture resisting compounds will not dry out with age, burn, or bake brittle under high temperatures.
3. Lubricated varnished cambric for high dielectric strength and added moisture resistance — protected from heat, flame and oxidation by felted asbestos walls.
4. Impregnated asbestos insulation that withstands heat of overloads and aging and won't become brittle, crack, rot or burn.
5. Conductors are perfectly centered in helically applied non-flowing insulation and will always remain so.

ROCKBESTOS 300 VOLT HEAT RESISTING FIXTURE WIRE
(Underwriters' Type AF)
Sizes No. 10 to 18 AWG stranded plain copper conductor insulated with black or white impregnated felted asbestos—with or without braid.

Rockbestos asbestos insulated fixture wires, approved by the Underwriters' Laboratories for lighting fixture wiring, will not bake out under the high socket temperatures developed in modern high-wattage fixtures. Also used for small motor and apparatus leads, switchboards, etc.

ROCKBESTOS A.V.C. 600 VOLT SWITCHBOARD WIRE
(National Electrical Code, Type AVB)
Sizes No. 18 to No. 4/0 AWG with varnished cambric and impregnated asbestos insulation and gray, black, white or colored flameproof braid.

Combine fire insurance and fine appearance in your switchboards with flame and heat resistant Rockbestos A.V.C. Switchboard Wire. Takes right angle bends without cracking because asbestos wall acts as a cushion beneath braid. Rockbestos A.V.C. Hinge and Switchboard Bus cables have same characteristics.

ROCKBESTOS A.V.C. 600 VOLT POWER CABLE
(National Electrical Code, Type AVA)
Sizes No. 18 AWG to 2,000,000 CM insulated with laminated felted asbestos, varnished cambric, and asbestos braid. Other constructions for service voltages to 5000.

This cable is recommended for power leads of heat-exposed equipment and circuits that run near boilers, steam lines, furnaces, kilns and other hot spots. It withstands high ambient and conductor temperatures and has ample moisture resistance.

ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE
In one to 19 conductors with individuals insulated like Motor Lead Cable, cotton braid covered and cabled with an asbestos braid over all. Standard strandings AWG No. 12—19/#25 and No. 9–19/#22. Other strandings on order.

Designed for applications requiring a multi-conductor control cable capable of withstanding high temperatures, corrosive fumes, oil, grease and moisture. It also eliminates fire hazard as it will not burn. Used by equipment manufacturers, power companies, steel mills.

ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE
(National Electrical Code, Type AVA)
Sizes No. 18 to 8 AWG insulated with varnished cambric, impregnated felted asbestos and asbestos braid. Sizes 6 to 4/0 have another wall of felted asbestos next to the conductor.

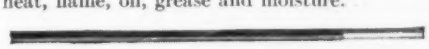
For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard around furnaces, ovens, lehrs, soaking pits, boilers, etc., this permanently insulated wire is ideal. It won't bake brittle, crack, rot, flow or swell.

ROCKBESTOS THERMOSTAT CONTROL WIRE
Sizes No. 14, 16 and 18 AWG in two to five conductors with .0125", .025" or (for 115 volt service) .031" of impregnated felted asbestos insulation and steel armor.

A multi-conductor wire for fuel burner controls, safety pilots, intercommunications and signal systems. Heatproof, fireproof insulation and steel armor give trouble-proof circuits.

ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE
(National Electrical Code, Type AVA)
Size No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid overall.

Use this apparatus cable for coil connections, motor and transformer leads exposed to overloads or high ambient temperatures. It makes a permanent installation as it is resistant to heat, flame, oil, grease and moisture.

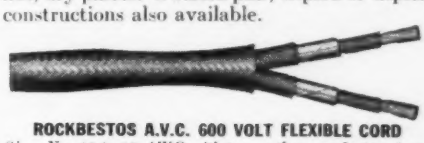


ROCKBESTOS ASBESTOS INSULATED MAGNET WIRE
Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Protect motors against heat-induced breakdowns with Class B windings of heat resisting magnet wire. Rockbestos A.V.C. Motor Lead Cable completes the failure-proofing.

ROCKBESTOS 300 VOLT HEAT RESISTING DUPLEX FLEXIBLE CORD
(Underwriters' Type AFPD)
Sizes No. 10 to 18 AWG stranded plain copper conductors insulated with impregnated felted asbestos, polarized, twisted together and covered with a cotton braid.

This heat-resisting cord is approved for use in lighting fixtures and is recommended for pendant types as it does not dry out or crack at the socket. Also on apparatus and appliances which develop heat in operation or are used in hot, dry places. Twisted pair, tripled or triplex constructions also available.

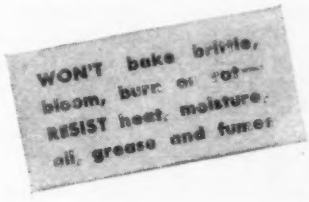


ROCKBESTOS A.V.C. 600 VOLT FLEXIBLE CORD
Sizes No. 10 to 18 AWG with two or three conductors insulated with impregnated felted asbestos, varnished cambric, felted asbestos, covered with heavy impregnated asbestos braid.

A heavy duty, high-dielectric, heat and moisture resistant flexible cord used in locomotive cab circuits, high wattage lighting units, floodlights and for leads on apparatus exposed to heat. Specify polarized conductors if desired. For high temperature applications where resistance to moisture is not required specify All-Asbestos insulated constructions.

ROCKBESTOS ALL-ASBESTOS 600 VOLT RHEOSTAT CABLE
(National Electrical Code, Type AIA)
Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this cable for wiring rheostats, switchboards, elevator and locomotive control panels and equipment exposed to heat, fumes or fire hazard — also for open power circuits in hot, dry locations. For flexible conductor specify Rockbestos All-Asbestos Flexible Apparatus Cable — for solid conductor, Rockbestos All-Asbestos Rheostat Wire.



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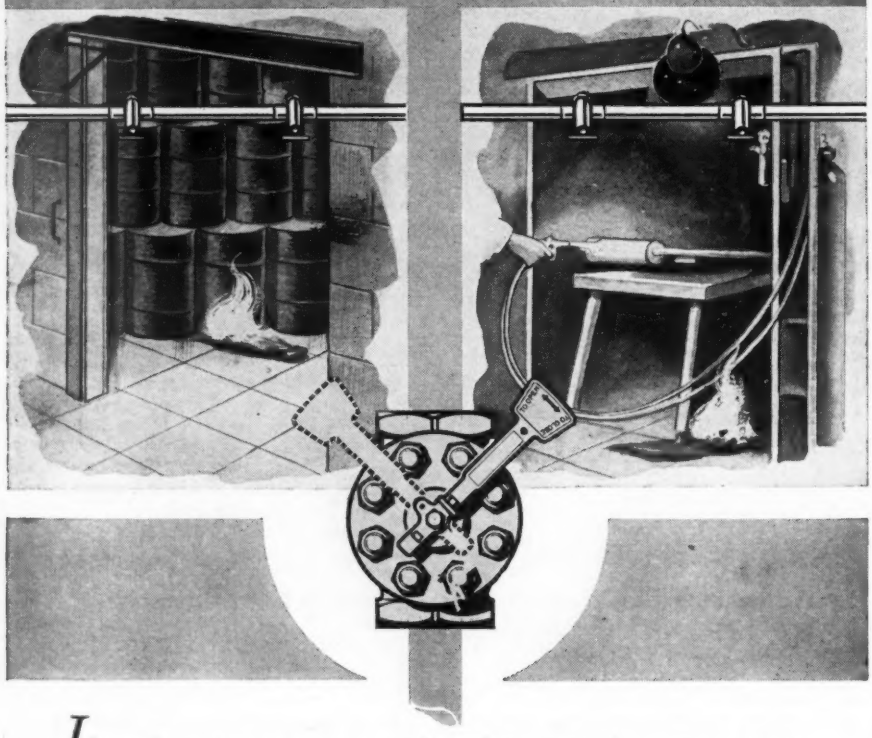
ROCKBESTOS

The Wire with Permanent Insulation

One C-O-TWO system

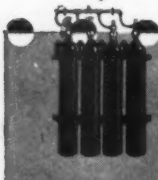
can protect two or more areas from fire



If you have two or more extra-hazardous processing areas or storerooms in your plant, you can safeguard them with one C-O-Two carbon dioxide system. The instant a fire starts in any one of the spots, simply turn a selector valve to flood the threatened space with clouds of cold, dry carbon dioxide gas. The fire is stopped quickly and easily.

C-O-Two is especially recommended for fires in electric equipment, motors, solvent tanks, spray booths, and flammable liquid storage. It is non-conducting, non-contaminating, non-deteriorating. It penetrates the smallest crevices and equipment, finishes, or fabrics.

Find out more about modern, clean carbon dioxide fire protection. Write for your free copy of "C-O-Two Kills Fire ... . Saves Life!"



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Please send me your free booklet, "C-O-Two Kills Fire . . . Saves Life."

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C-O-TWO

joined the Bureau in 1912 and was appointed chief of the engineering instruments and mechanical appliances section in 1928. The section of which Mr Stutz has been chief is engaged mainly in testing activities for other government agencies.

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Divisional Changes Made by Central Maine Power

Central Maine Power Co, through President W. F. Wyman of Augusta, has appointed Robert E. Brackett manager of the southern division with headquarters at Portland; George E. Haggas was named division plant manager, and Donald M. Libby manager of a newly established Portland district. Fred D. Gordon, vice-president of the company and former manager of the division, will continue as a director of Central Maine Power, vice-president as hitherto, and as advisory consultant on southern division activities.

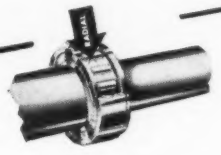
Mr Brackett will supervise the office, stores, personnel and electrical distribution and sales of the division, which includes most of Cumberland and York counties. A graduate of the University of Maine, he joined the predecessor Cumberland County Power & Light Co in 1929 as auditor and assistant treasurer, soon becoming director of the auditing department and in 1935 assistant secretary. Since the merger with Central Maine in 1942 he has been assistant treasurer of the latter. Mr Haggas, an engineering graduate of the University of Michigan, joined the CCP&L company in 1915 as chief engineer, later being made assistant to the general manager and then plant superintendent and assistant to the vice-president, southern division. Mr Libby, a University of Maine graduate in engineering, joined the CCP&L in 1922 in the meter and general service department. In 1922 he was made assistant to the power engineer and in 1928 power engineer. He served in both world wars, holding a colonelcy at his discharge in 1946, when he became rate engineer. Mr Gordon entered the industry in 1896, and has had a distinguished executive career with the utilities now merged with the CMP at Lewiston and Portland.

•

► Titus G. LeClair, chief staff engineer, Commonwealth Edison Co, Chicago, and past-president of the Western Society of Engineers, has been elected chairman of the Washington Award Commission for the year 1947-48. The commission is charged with the duty of

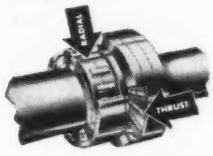
Why RIGHT ANGLE LOADING ASSURES LONGER BEARING LIFE

Right Angle Loading splits compound loads into the two component parts of pure radial and pure thrust . . . and carries each of these components on separate bearing assemblies.

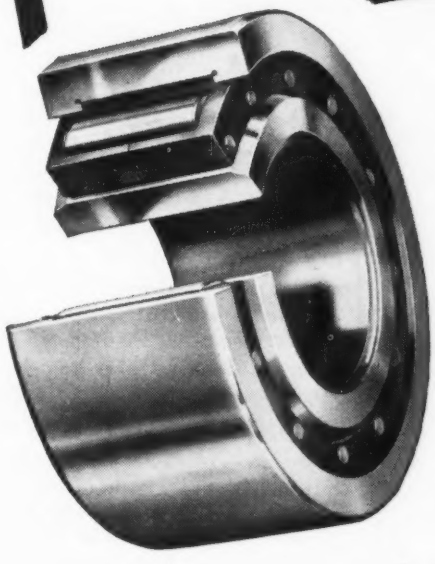


- When the load is pure radial, it bears at a right angle to the rollers.

- When the load is pure thrust, it bears at a right angle to the rollers.



- When radial and thrust are combined the two loads are resolved separately at a right angle to the rollers.



ROLLWAY

RIGHT-ANGLE-LOADED BEARINGS

Reduce shut-downs and maintenance costs

They prevent wedging of rollers and pinch-out. Reduce roller end-rub with its wearing friction. Eliminate complicated stresses. Substantially reduce unit pressures. Eliminate compound or oblique loads, and the resultants of oblique loads. Carry greater radial or thrust load capacity in any given dimension. Assure greater resistance to shock loads and vibration. Give longer life expectancy.

FREE SERVICE!

Send us a print or detailed statement of load, speed and operating conditions for free analysis and recommendation. Your information is held confidential.

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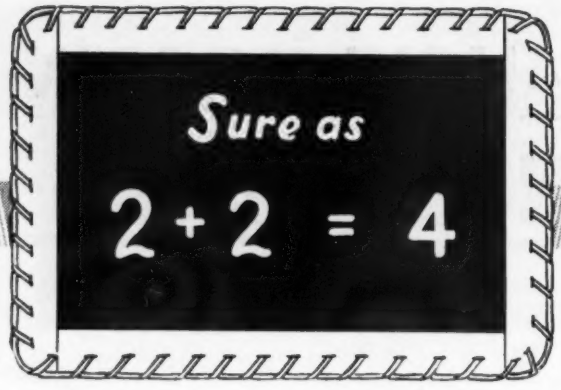
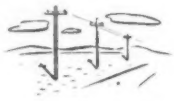
ROLLWAY BEARING COMPANY, INC., SYRACUSE, N. Y.

SALES OFFICES: Philadelphia • Boston • Pittsburgh • Cleveland • Detroit • Chicago • Minneapolis • Houston • Los Angeles



Yes, the chemical formula for pentachlorphenol, active ingredient of Chapman "Penta" Preservative*, is fixed and unvarying. That means you get exactly the same thorough, long-lasting protection against termites and decay from every standard treatment of "Penta" Preservative—no matter when or where you buy it. There's no slightest chance of chemical variation, as there may be in the make-up of old-fashioned wood preservatives.



No other commercially acceptable material can give your poles and cross-arms better protection against all wood enemies than Chapman "Penta" Preservative. Ten-year tests on 21 commonly used preservatives have proved that. Your linemen will tell you they prefer poles treated with "Penta" Preservative, since the treated poles are clean, not sticky.

"Penta" Preservative treatment costs no more than other outdated methods, and is applied with the same equipment. You can obtain Chapman "Penta" Preservative in all parts of the United States. Write us for details.

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Chapman "Penta" Preservative contains *Pentachlorphenol*
a product of
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selecting the engineer whose professional attainments have preeminently advanced the welfare of mankind.

•

Engh Elected President of Pyle-National Co

Harold V. Engh, executive vice-president of Anaconda Wire & Cable Co, New York, has been elected president and general manager of the Pyle-National Co.

Mr Engh began his business career with Chicago Insulated Wire & Mfg Co, serving in various departments. Subsequently he was elected vice-president of Illinois Wire & Cable Co. In 1928 he was made president of Inland Cable Co, and when Inland consolidated with Anaconda Wire & Cable in 1929, Mr Engh joined Anaconda as vice-president.

•

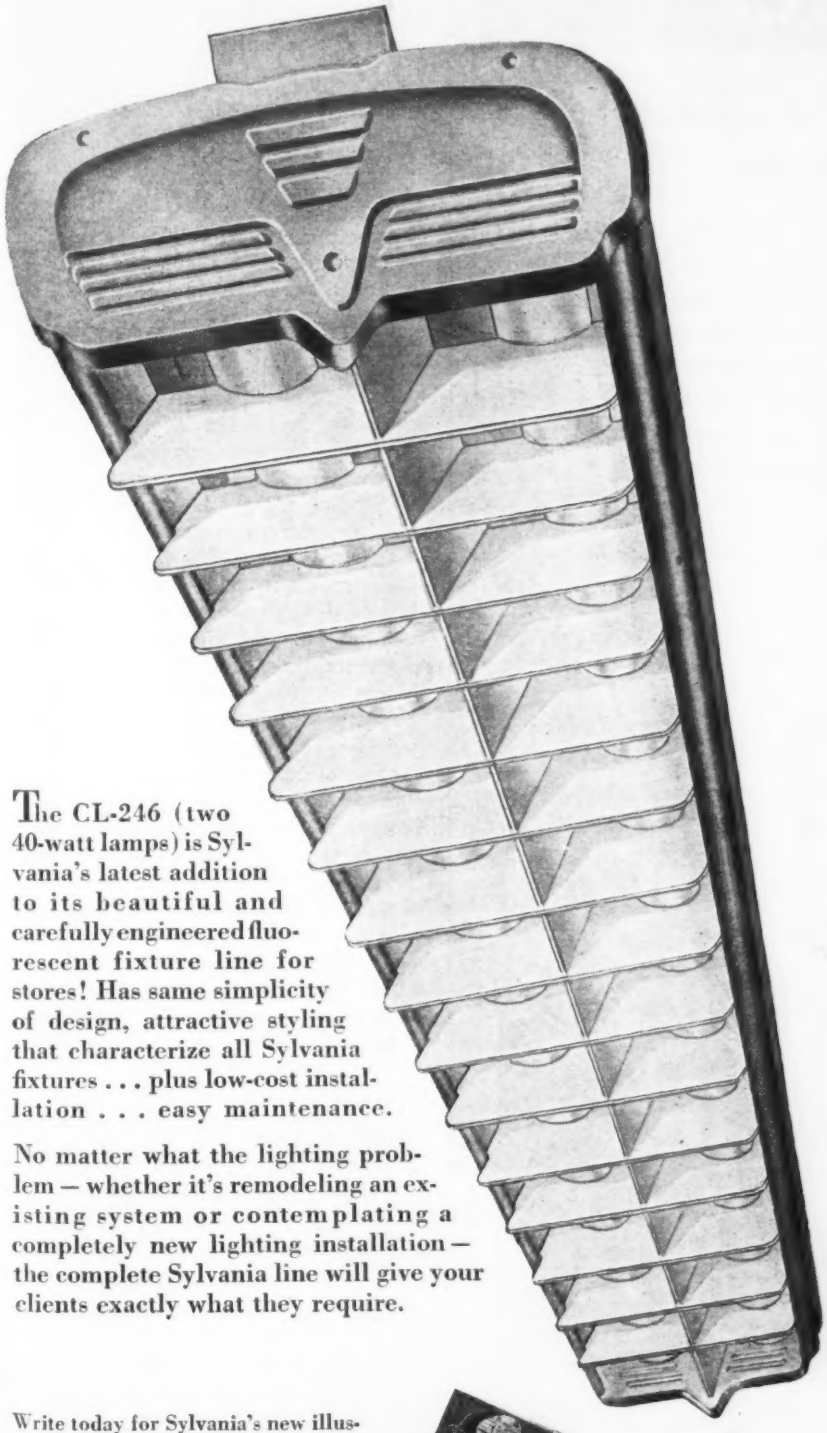
► WILLIAM B. NIMROD has been named by Mayor Bowron of Los Angeles to the Board of Water and Power Commissioners, succeeding ALBERT W. ANDERSON, resigned. Mr Nimrod served on the commission from 1939 to 1942. The mayor's reappointment of Robert Heffner to the board was also approved by the City Council.

► G. MASON SPEER has been elected by the Abbeville, S. C., City Council to succeed C. P. Townsend, recently resigned, as head of the Water-Light plant at Abbeville. He is a graduate of Clemson College and was with the Charles Co of New York as consulting engineer. Since 1935 he has been with the Public Service Commission of Columbia, S. C.

► WILLIAM H. BALKE, JR., has been appointed Northern Division engineer of the Connecticut Light & Power Co to succeed Gerald H. Davis, now Western Division engineer. Balke, a Yale graduate, has been with the utility since 1929.

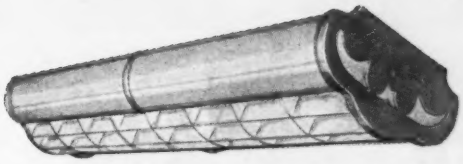
► DR ARPAD L. NADAI, consulting engineer of the Westinghouse Research Laboratories, has been awarded the Worcester Reed Warner Medal by the American Society of Mechanical Engineers. The medal honors noteworthy contributions to the permanent literature of the engineering profession. Earlier this year Dr Nadai delivered the James Clayton Lecture before the British Institution of Mechanical Engineers in London and Manchester. His paper on the plastic flow of metals, in which field he is an internationally known specialist, won the acclaim of scientists

THE MOST COMPLETE LINE OF FLUORESCENT FIXTURES FOR STORES

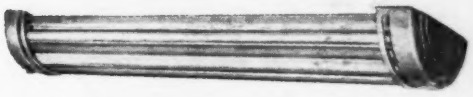


The CL-246 (two 40-watt lamps) is Sylvania's latest addition to its beautiful and carefully engineered fluorescent fixture line for stores! Has same simplicity of design, attractive styling that characterize all Sylvania fixtures . . . plus low-cost installation . . . easy maintenance.

No matter what the lighting problem — whether it's remodeling an existing system or contemplating a completely new lighting installation — the complete Sylvania line will give your clients exactly what they require.



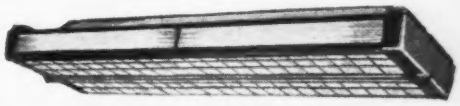
C-205 Complete with two 40-watt lamps. By pressing two fastening levers, the entire assembly swings down, providing a basket for lamps.



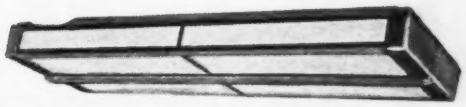
C-200 Ideal for grocery, variety and drug stores! Reflector is joined to top-housing with only 3 screws and can be removed without disturbing wiring, ballast, starters or lampholders.

C-201 Glass-diffused; four 40-watt lamps. Fluted panels are hinged to end caps and swing outward or lift away from the fixture entirely.

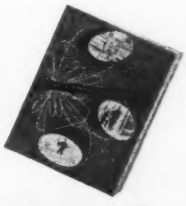
C-440 Complete with four 40-watt unshielded lamps. The end caps snap open and swing down for easy lamp or starter replacement.



CL-440 The shield assembly of this louvered version of C-440 hinges downward and may be completely removed for easy cleaning.



CG-440 Equipped with glass diffusing panels, this four 40-watt fluorescent fixture combines low fixture brightness with high light output and efficiency.



Write today for Sylvania's new illustrated descriptive booklet entitled *The Right Ways To Light Your Merchandise.* Sylvania Electric Products Inc., Lighting Division, 213 Derby St., Salem, Mass.

"Fluorescent at its Finest"
FOR STORE, OFFICE, FACTORY, HOME

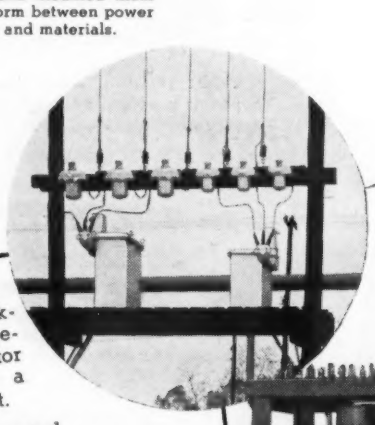
SYLVANIA ELECTRIC

Automatic Starters
for 2300 Volt Motors
by EC&M

Complete enclosure of all high voltage parts not only provides a *shock-proof* installation but reduces time and material in installation. With the mechanism totally oil-immersed, operating parts are always lubricated and also protected from corrosion. Push button operation brings the motor up to speed with greater skill than human hands could do it.

Ask for Bulletin 1047-C.

Prominent oil refinery selected EC&M 2300 volt Starters and mounted them out-of-doors on platform between power poles . . . saved time and materials.



1 Single, quick-break, double-throw contactor operated by a single magnet.

2 Two liberally-rated auto-transformers marked T_1 and T_2.

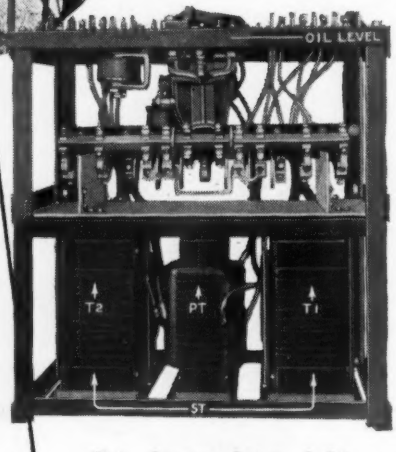
3 Potential transformer (marked PT) for 220 volt push button circuit.

4 Current limit relay trips mechanical latch to transfer from reduced to full voltage.

5 Variable reactor on top of mechanism permits quick change of transition-setting, when desired.

6 Continuous torque acceleration.

7 Adjustable, magnetic type overload relays, arranged for magnetic reset from push button.



Note clean-cut design of this reduced voltage starter mechanism for 2300 volt motors.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79th STREET • CLEVELAND 4, OHIO

in England and on the Continent. Born in Budapest, Hungary, Dr Nadai was educated at Swiss and German universities. He came to the United States in 1922 to deliver a series of lectures at the University of Pittsburgh, and a year later joined the Westinghouse Research Laboratories. Dr Nadai will receive the medal at the society's annual meeting in Atlantic City in December.

•

Westinghouse Electric Makes New Appointments

Appointment of R. D. Duthie, of Chicago, Ill., as assistant to the vice-president, has been announced by B. W. Clark, vice-president in charge of sales for the Westinghouse Electric Corp. Mr Duthie will head the company's chain store activities and will be located in Pittsburgh. He succeeds A. J. Bronold, who has been transferred to the company's B. F. Sturtevant Division in Boston, Mass., as general agency and contractor manager.

T. O. Armstrong has been appointed director, plant labor relations. Mr Armstrong will be responsible for the coordination and direction of over-all plant training, safety and suggestion system programs and research work in the field of labor relations and training. He will be located in the Pittsburgh office. A nationally known authority in his field Mr Armstrong has taken an active part in the leadership of many important industrial relations conferences and has cooperated in the industrial relations training field with a number of eastern universities. He is also author and co-author of a number of publications on the subjects of personnel, safety and supervisory-employee relationships. Mr Armstrong joined Westinghouse in 1927.

N. H. Callard has been appointed manager of rural electrification, industry sales departments, with headquarters at East Pittsburgh, Pa. Mr Callard will be responsible for development plans and coordination of sales efforts pertaining to the farm and rural market of the industry sales departments and the manufacturing division. Mr Callard recently returned from war service in the Navy and with the Office of War Information in India.

Dr R. M. Zabel has been appointed to the executive engineering staff of the Westinghouse Lamp Division, Bloomfield, N. J. Dr Zabel, who since 1936 has been chief of the lamp division of Sylvania Electric Products Inc. was named staff assistant to Dr A. M. Hageman, manager of engineering for the Westinghouse Lamp Division. He is the author of scientific articles and holds several patents. He is a member

...J-M TRANCELL MATERIALS
give you safer cell structures

CELL STRUCTURES built with J-M Trancell provide greater safety for station operators... give adjacent equipment greater protection against heat transmission. The reason—J-M Trancell is completely fireproof, rotproof and rustproof . . . is erected entirely *without* water to form a *dry* housing that guards against shorts.

You'll find, too, that Trancell is economical to install because it comes in large sheets that are easily workable . . . can be cut, drilled, and bolted right on the job. Light in weight, Trancell permits the housing of equipment on balconies and upper floors without danger of overloading.

Basically asbestos, J-M Trancell Materials are available in a wide variety of types and combinations to meet every requirement of high-voltage service. You can order Trancell pre-cut to your special dimensions . . . or have it cut by your own maintenance department thereby saving shut-down time, detail drawings, and materials. For complete information, write Johns-Manville, Box 290, New York 16, New York.

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TRANCELL
an asbestos product
for housing electrical equipment

GUARDS THE CABLES with 4-way protection!

Cable is the lifeline of power and communications systems. Give it this vital 4-way protection with ORANGEBURG* CONDUIT . . . .

1. Protection from cable sheath abrasion . . . because of its smooth bore, ORANGEBURG reduces the danger of damage to the sheath when cable is pulled into duct.

2. Protection from pulling tension . . . because the friction coefficient is lower in ORANGEBURG than in ducts made of other materials, lessening strains caused by cable pulling tension.

3. Protection from water infiltration . . . because ORANGEBURG'S impermeable wall gives cables maximum safety from ground water and resulting corrosion.

4. Protection with cable movement . . . because the smooth surface of ORANGEBURG reduces wear on the sheath as the cable expands and contracts with changing loads. *Write for the Catalog today.*

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WITH 50 YEARS EXPERIENCE IN THE MANUFACTURE OF NON-METALLIC CONDUIT AND PIPE, SERVES THE POWER AND LIGHT, TELEPHONE, GENERAL CONSTRUCTION, CHEMICAL, PETROLEUM, PLUMBING AND BUILDING SUPPLY FIELDS WITH ELECTRICAL FIBRE CONDUIT . . . ELECTRICAL UNDERFLOOR DUCT SYSTEMS . . . AND FIBRE PIPE FOR NON-PRESSURE USES.

of the Illuminating Engineering Society, the American Institute of Electrical Engineers and the American Physical Society.

OBITUARY

Dr William E. Wickenden

Dr William E. Wickenden, retired president of the Case Institute of Technology, whose death was announced in ELECTRICAL WORLD, September 6, page 5, was well known as an engineer and educator.

Holder of honorary degrees from eleven institutions, he was graduated with honors from Denison University, Granville, Ohio, in 1904. He served as an assistant and later associate professor of electrical engineering at the Massachusetts Institute of Technology from 1909 to 1918, resigning to become personnel manager of Bell Telephone Laboratories and chairman of the personnel committee of Western Electric Co. In 1921 he became assistant vice-president of the American Telephone & Telegraph Co and in 1923 was made director of the Society for the Promotion of Engineering Education. He was awarded the Lamme Medal in 1935 by SPEE for his writings on the comparative study of engineering education in the United States and Europe.

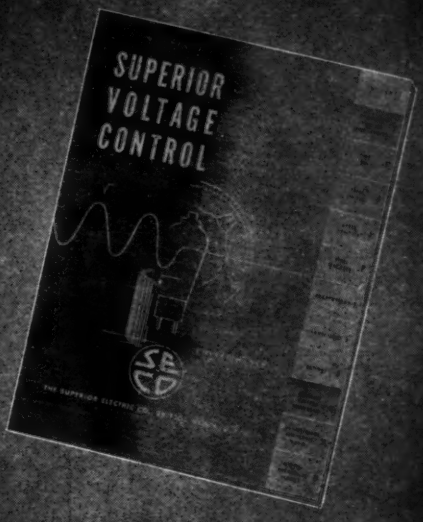
It was in 1929 that he became president of the then-named Case School of Applied Science (changed in July, 1947, to Case Institute of Technology). Dr Wickenden died less than 24 hours after his retirement became official.

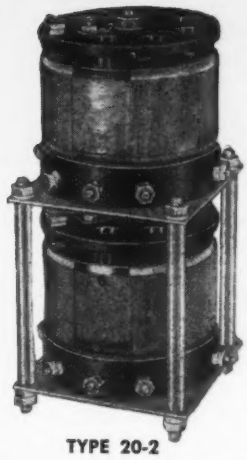
Member of half a dozen engineering societies and of five engineering fraternities, he had been president of the American Institute of Electrical Engineers, chairman of the Ohio planning board, president of the Ohio College Association and a member of the American Council on Education. Only recently Dr Wickenden was named a representative of the engineering profession on the United States Commission to the United Nations Educational,

New Bulletin 547

Features VOLTAGE CONTROL by SUPERIOR ELECTRIC

All the information required for selection of the correct voltage control apparatus is included—
FOR EXAMPLE . . .

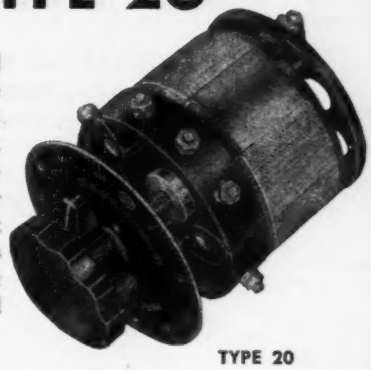




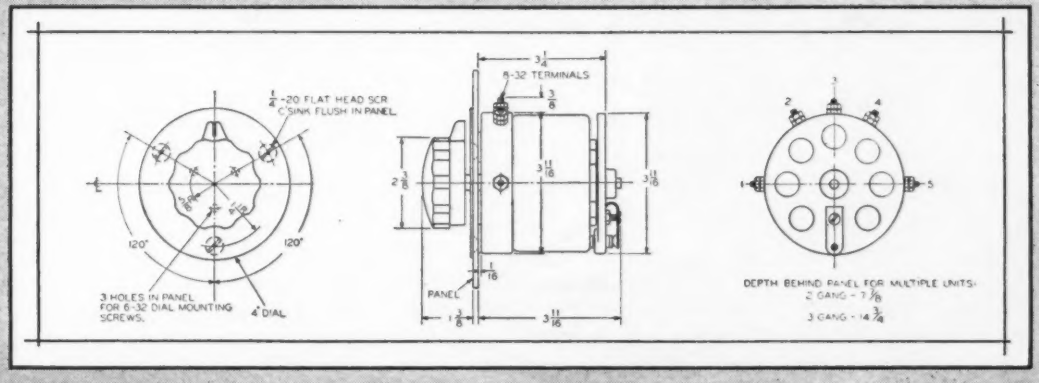
TYPE 20-2

POWERSTAT TYPE 20

Although the smallest in physical and electrical size of all POWERSTAT variable transformers, type 20 possesses all the essentials of superior voltage control equipment. It has excellent regulation . . . high efficiency . . . smooth control . . . and unusually rugged mechanical construction. Its current rating of 3.0 amperes exceeds all other units of comparable mounting dimensions. For three phase operation, type 20 can be ganged for wye or open-delta operation.



TYPE 20



To get your copy of Bulletin 547 . . . for more information on POWERSTAT type 20 and other voltage control equipment write

SUPERIOR ELECTRIC, 1092 Laurel Street, BRISTOL, CONNECTICUT.

THE SUPERIOR ELECTRIC CO.

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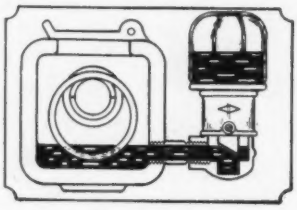
POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A·C POWER SUPPLY • STABILINE VOLTAGE REGULATORS

TRICO Bearing Protection
ENDS SHUTDOWNS

TRICO "Opto-matic" OILERS eliminate the old-fashioned "trust-to-luck" hand oiling method by supplying the *right amount* of oil at the *right place* —**automatically.** There's no guesswork—no human failure—no down-time for hand-oiling—no production losses—no fire and accident hazards.



THE MODERN WAY

Opto-matics feed new oil automatically and positively the instant oil is consumed. One filling lasts a long time and no attention is required except to keep oil in the visible bottle.

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Get complete information on constant level, Gravity, Wick, Thermal and Bottle Oilers. There's a style for every application.

TRICO

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MAGNIFIQUE!... HOT OR COLD...NEVAIR SMEARS OR DRIES OUT.
AH!--DONE TO PERFECTION RIGHT TO ZE CORE.
VOILA! LA PIECE DE RESISTANCE... GOLD SEAL TAPE!

Jenkins Bros. also make Diamond Seal Friction and Rubber Tapes which meet ASTM and Federal Specifications.

A Roll Cooked Up by Experts

● Like skilled chefs, tape experts in the Jenkins laboratory check every step in the manufacture of Gold Seal. That's why Gold Seal always has plenty of tack . . . never ravels, peels, smears your hands, or dries out. Ask for Gold Seal, by the box or the handy ten-roll can. Every roll is cellophane wrapped. Jenkins Bros. (Rubber Division) 80 White Street, New York 13, N. Y.

JENKINS *Gold Seal Tape*
FRICTION-RUBBER

MADE BY JENKINS BROS . . . MAKERS OF FAMOUS JENKINS VALVES

Cultural and Scientific Organization and was to represent the Joint Engineering Council, composed of a group of engineering societies.

•

Norman H. Coit

Norman H. Coit, chairman of the board of directors of the South Carolina Electric & Gas Co, Columbus,

S. C., died on September 3 in a Philadelphia hospital to which he had been admitted a month ago for treatment of a throat ailment. He was 52 years old. Mr Coit became board chairman of the South Carolina utility last year after having served as president and general manager for six years.

Mr Coit was born in Indianapolis, Ind., and was graduated from the University of Colorado in 1917 with a degree in electrical engineering. His first connection after graduation was with the Mountain States Telephone & Telegraph Co in Denver and Salt Lake City. Following that connection he went to Nebraska with the Western Public Service Co. In 1923 he became connected with the General Gas & Electric Corp on its Pennsylvania properties, from which point he was transferred to the Florida Public Service Co in Orlando in the capacity of general superintendent.

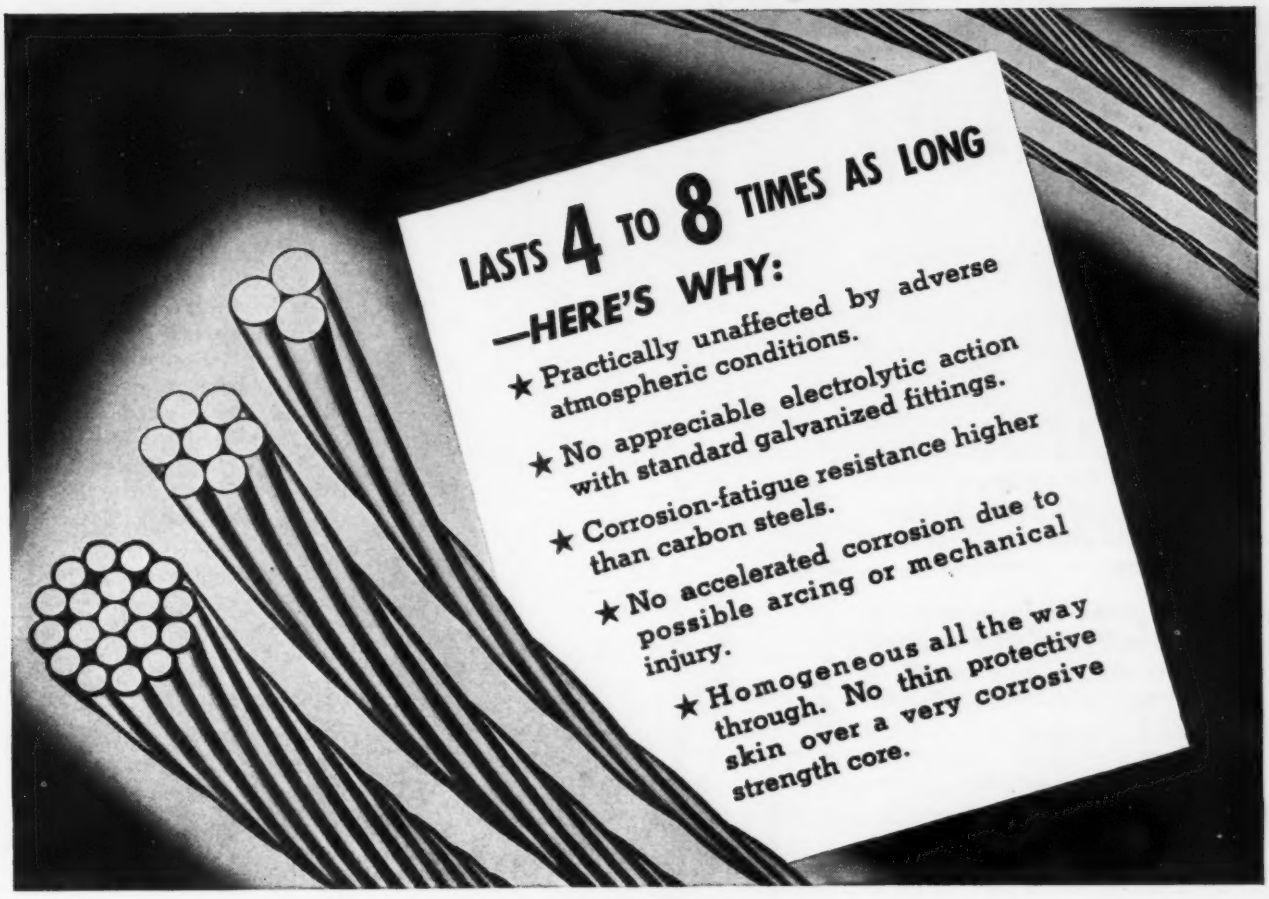
It was in 1929 that Mr Coit was transferred to the South Carolina Company as vice-president and general manager, in which capacity he served until 1940 when he was elected president and general manager.

•

➤ Alden C. Cummins, general superintendent. Carnegie-Illinois Steel Corp. Youngstown, Ohio, died on July 10. He was 60 years old. Mr Cummins began his association with Carnegie-Illinois Corp in 1911, at the Duquesne, Pa., works. He was named superintendent of the electrical department in 1919, and assistant general superintendent

PAGE *Stainless Steel* STRAND

for Ground Wire, Guy or Messenger Wire


LASTS 4 TO 8 TIMES AS LONG
—HERE'S WHY:
★ Practically unaffected by adverse atmospheric conditions.
★ No appreciable electrolytic action with standard galvanized fittings.
★ Corrosion-fatigue resistance higher than carbon steels.
★ No accelerated corrosion due to possible arcing or mechanical injury.
★ Homogeneous all the way through. No thin protective skin over a very corrosive strength core.

. . . after 1966—What?

If an installation of galvanized messenger, guy or overhead ground wire would have to be replaced for strand failure at the end of twenty years, it would be sound economy to install Page Stainless Steel Strand — even if it cost 4 times as much (which it does not).

If, due to corrosion from acid or salt air or erosion due to blown sand, replacement would be necessary in ten years — you could pay 8 times as much for Page Stainless Steel Strand and come out ahead.

Send for the folder that gives you complete information.

ACCO

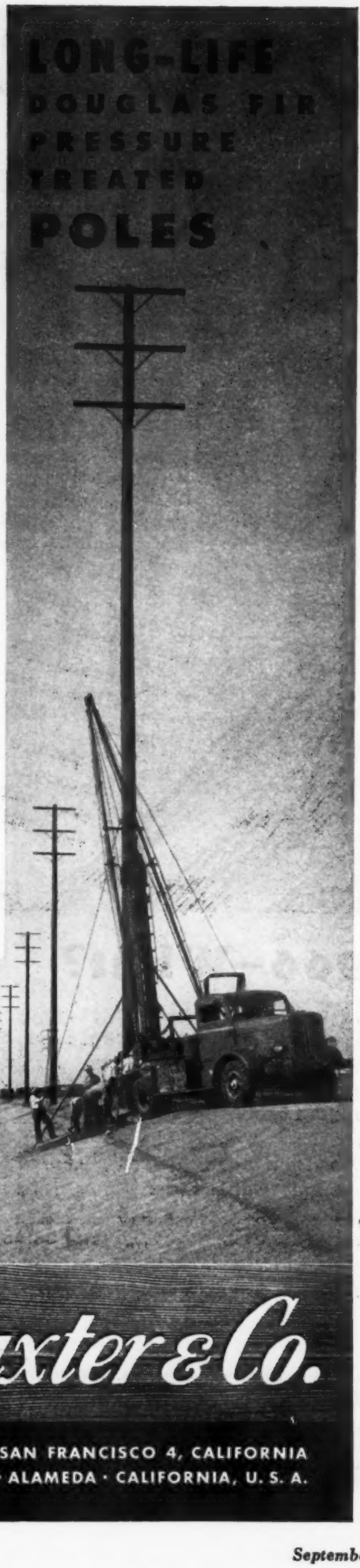
TRADE MARK

Monessen, Pa., Atlanta, Chicago, Denver, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, Portland, San Francisco, Bridgeport, Conn.

PAGE STEEL AND WIRE DIVISION
AMERICAN CHAIN & CABLE

BAXCO

LONG-LIFE DOUGLAS FIR PRESSURE TREATED POLES



In transmission lines–distribution, lighting or telephone systems–wherever dependable service is of prime importance you can count on Baxco Long-Life Poles to do the job.

Baxco Long-Life Poles are strong, straight, machine shaved, Coast-type Douglas Fir pressure treated with creosote and pentachlorphenol to resist rot, termites and deterioration.

You'll be proud of these poles in your line and more than satisfied with their long maintenance-free service. Write or wire us your inquiries.

Also Produced by
J. H. Baxter & Co. of Oregon
an associated company
Plant and Yard–Eugene, Oregon

J. H. Baxter & Co.

333 MONTGOMERY STREET · SAN FRANCISCO 4, CALIFORNIA
LOS ANGELES · LONG BEACH · ALAMEDA · CALIFORNIA, U. S. A.

of the plant in 1932. Transferred to Pittsburgh, Pa., in 1936, he was appointed assistant manager of operations in that district. He became general superintendent at Youngstown in 1940. A life member of the Association of Iron and Steel Engineers, Mr Cummins served as president of that association in 1925 and was an honorary director for several years.

▶HENRY G. BRADLEE, chairman of the executive committee and a director of Stone & Webster, Inc, died on September 3 at his home in Brookline, Mass., after a brief illness. He was 76 years old. Mr Bradlee became associated with the utilities management firm in 1891. For many years before it was incorporated he was a partner, and later he became a vice-president and treasurer. In 1927 Mr Bradlee, as a member of the flood-control committee of the Chamber of Commerce of the United States, made a tour of the flooded areas in the Mississippi Valley. Besides being a director of Stone & Webster, Inc, Mr Bradlee held directorships in the Tampa Electric Co, the Fall River Gas Works, the Chicago, Wilmington & Franklin Coal Co, and the Railway Light Securities Co. He had also been a director of the Stone & Webster Engineering Corp, Stone & Webster Realty Corp and the Stone & Webster Service Corp. Mr Bradlee was a graduate of the Massachusetts Institute of Technology.

▶NORMAN W. STORER, retired consulting railway engineer, Westinghouse Electric Corp, died on June 5. A native of Orangeville, Ohio, and a graduate of Ohio State University, Mr Storer entered the employ of the Westinghouse company at East Pittsburgh, Pa., in 1891, following graduation and maintained that association until his retirement in 1936. In 1893 he became assistant to B. G. Lamme on the design of d-c machines, especially railway motors. During this period he developed a method of rating railway motors which later was adopted as standard by both the AIEE standards committee and the International Electrotechnical Commission. In 1904 the company's engineering department was reorganized, and Mr Storer was made engineer of the railway division, devoting his entire time to electric transportation. In 1926 he was appointed consulting railway engineer. Mr. Storer was awarded the Lamme Medal of the American Institute of Electrical Engineers for 1939 "for meritorious achievement in the development of apparatus and machinery for electrical transportation." He was a fellow of AIEE and served twice as vice-president. Mr. Storer was the author of many technical papers.

7th among the features of DIEFLEX

VARNISHED TUBING PRODUCTS is . . .

The smooth inside bore of Dieflex Varnished Tubing and Sleeving helps speed assembly and reduce manufacturing costs, just as do the other 7 outstanding features of this quality insulation. These advantages, plus long life, make Dieflex attractive both to the manufacturer and the ultimate product user.

Get these advantages for your own production. Dieflex is available with either a cotton or glass fiber base to meet every insulation requirement.

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ELECTRICAL IMC INSULATION

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MILWAUKEE 2, 312 East Wisconsin Ave.
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REPRESENTATIVES in: DETROIT 2, 11341 Woodward Ave., MINNEAPOLIS 3, 1208 Harmon Pl., and PEORIA 5, 101 Heinz Court.

If *this* is your fire hazard

—here's how to SAFEGUARD it!

Apply carbon dioxide with a Kidde Wheeled Extinguisher

Kidde Carbon Dioxide Wheeled Extinguishers combine full mobility, ease of handling and terrific fire-fighting punch.

They get to outdoor equipment and isolated danger spots *fast*, maneuver easily at the scene of the fire. Nozzles and releases are specially designed for ease of handling. Shut-off valve right on the nozzle handle allows operator to stop carbon dioxide discharge while he changes his fire-fighting position.

And with their carbon dioxide capacities of 50, 75 and 100 pounds, they take care of tough fires in a hurry!

Remember . . . carbon dioxide is dry, inert, non-conducting, clean.

Ask a Kidde representative for full details.

Walter Kidde & Company, Inc., 930 Main Street, Belleville 9, N. J.

The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

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FIRE PROTECTION HEADQUARTERS

MANUFACTURERS & MARKETS

Hotpoint Purchases Two A-C War-Plants from WAA

Sale of two surplus war-plants in Milwaukee, Wis., to Hotpoint, Inc, Chicago, Ill., for $2,122,000 has been approved by the War Assets Administration. The plants are the Allis-Chalmers Manufacturing Co Plants No. 2 and No. 3, which during the war produced turbo-superchargers for aircraft.

Hotpoint will use the plants for the manufacture of electric dishwashers and electric hot water heaters. Employment is expected to be provided for 1,000 persons.

Sale prices were $2,072,000 for Plant No. 2 and $50,000 for Plant No. 3. Approximate cost to the government of both was $4,400,000. Machinery and equipment not later purchased by the corporation will be removed by the government.

The sale is subject to compliance with provisions of the Surplus Property Act.

•

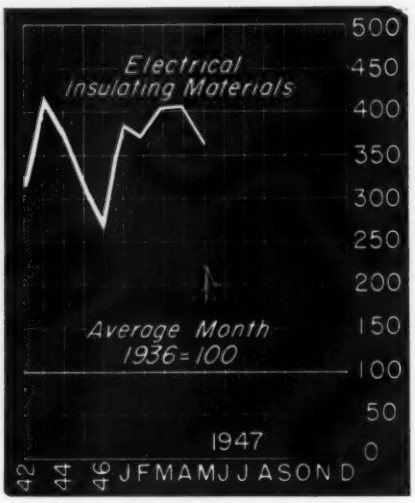
Modern Controls–Hevi Duty Make Haug Regulator Pact

Joint announcement has been made by Milton M. Morse, president of Modern Controls, Inc, Chicago, and Harold E. Koch, president of Hevi Duty Electric Co, Milwaukee, that a contract had been entered into between the two companies under which production of the Haug type constant current regulator will be undertaken exclusively by Hevi Duty. Sales will be handled by both companies.

•

Forms Tube Parts Section

A new tube parts and equipment sales section to sell electronic tube parts and tube-making equipment to manufacturers has been established in the tube division of General Electric Co's electronics department at Schenectady, N. Y. Joseph W. Whiteside, a GE employee since 1929, has been appointed sales manager of the new section with headquarters at Schenectady.



Insulating Materials Sales in May Decrease 11%

Sales billed on electrical insulating materials during the month of May dropped sharply from the preceding month, the index compiled by the National Electrical Manufacturers Association indicates. The index moved downward to 361 from 405 in April, a drop of 11 percent. The index stood at 242 in May, 1946, this year's figure representing an increase of 49 percent.

The monthly index of orders received of motors and generators is being revised to a quarterly basis. The revised index will be released quarterly beginning with the second quarter of 1947.

•

Adds Fluorescent Tubes

The Industrial Electronics Corp, Newark, N. J., has begun the manufacture of fluorescent tubes, Bert R. Joel, executive vice-president of the company, has announced. The current output will consist of fluorescent tubes of various sizes and color, and will be distributed in the domestic market only.

•

Westinghouse Television

Westinghouse Electric Corp will have its first television sets in dealers' stocks by November 1. The instrument will be a table-type straight television receiver and will sell for about $400.

General Electric Builds Television Unit for WOR

The General Electric Co is building a high-power television transmitter at its Electronics Park plant in Syracuse, N. Y., for WOR, New York, which will use it to operate a new television station to be established in that city with call letters WOR-TV. It will operate in channel 9 (nine) at a frequency of 186-192 million cycles per second.

In making this announcement, C. A. Priest, manager of the GE transmitter division, said the unit is expected to be delivered in March and WOR-TV personnel will have it on the air during the summer of 1948. It will project programs into homes over a radius of 45 miles from its New York site.

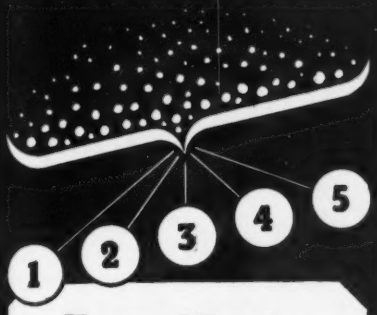
•

Brown Instrument Course

Brown Instrument Co has announced that next month it will start the twelfth consecutive year it has conducted continuing courses of training in industrial measuring and control devices at its

A WINNING HAND of checks, not cards, is bringing a smile to the face of Mike Defino, wireman at the East Pittsburgh Works of Westinghouse Electric Corp. In 20 years, he has won 300 awards under the company's suggestion system. His awards have totalled approximately $10,000

How to Plan Your Future Rate Structure



From 95 rates to only 5!

Typical long range plan for sound growth through progressive rate simplification as developed by EBASCO consultants for a Southern utility.

IF you need practical answers to your rate-structure problems, look to EBASCO consultants for down-to-earth help.

Specialists with long experience in all types of utility rate problems, these men also have the assistance of EBASCO specialists in the related fields of engineering, operation and finance.

They're available for consultation and assistance on any phase of your problems—including the preparation and presentation of data before regulatory bodies.

Write for folder on
Rate and Economic Research for Public Utilities.

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SERVICES
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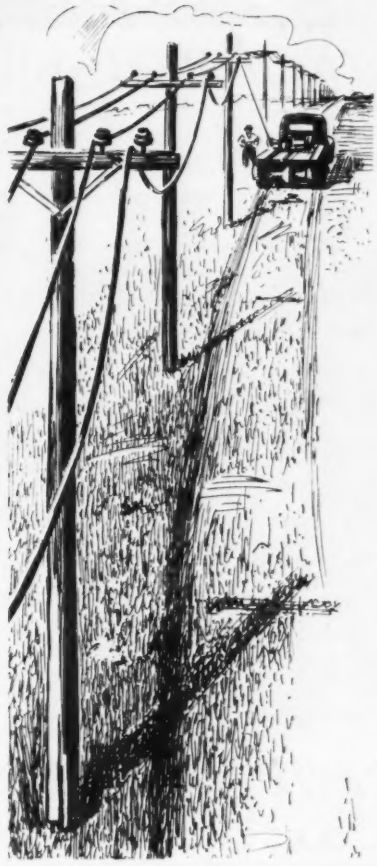
SERVICES OFFERED—Accounting • Appraisal • Budget • Consulting Engineering • Design & Construction • Financial • Industrial Relations • Inspection & Expediting • Insurance • Purchasing • Rate & Pricing • Research • Sales & Marketing • Tax • Traffic

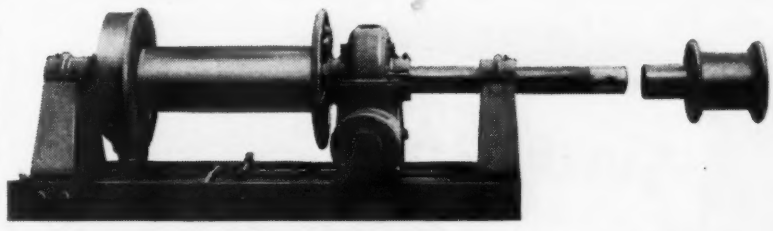
FOR REAL WORK . . .



(And Reel Work) Use A

TULSA WINCH

A winch is a "Must" item on line trucks for most utility companies . . . And many of these companies are finding that the TULSA WINCH is best by far in performance, wear, and safety. Wire-stringing is just one of the many applications in which Tulsa Winches are proving invaluable . . . Pole raising, hoisting transformers, load skidding, mud rescue . . . wherever there is lots of steady, dependable power required to move a load.



Tulsa Winch with Extended Drum Shaft
for Public Utility Companies
(Note Detachable Cathead and Adapter)

"Tulsa Winches Will Not Overheat"

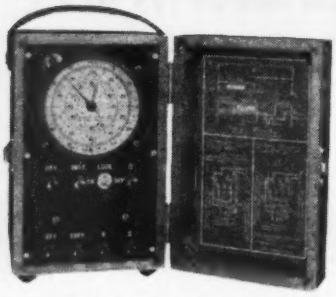
Experienced winch-truck drivers report that Tulsa Winches stand up on long, heavy hauls without overheating. Best materials, careful manufacture, expert design make TULSA WINCHES most profitable for you. The special utility winch illustrated is built to your requirements.

A Complete Line of Winches for All Trucks of ½-Ton to 8-Ton and Larger

Write for Literature and further information. Dept. E 122.

Tulsa Winch
TULSA, OKLAHOMA DIVISION OF VICKERS Inc.

FOR ACCURATE RELAY TESTING . . .



Standard Portable CYCLE COUNTERS

STANDARD Model AC-1 — heavy-duty synchronous motor . . . walnut finish case . . . weighs only 6 lbs. . . . for 60 cycle, 115-230 volts; 50 cycle. 115-230 volts; 25-60 cycle, 115 volts.

Tried, approved, and used by electric light and power companies everywhere, STANDARD Cycle Counters provide a positive method **for checking the delayed action of protective relays.**

Indicating and totalizing hands, controlled by an electromagnetic clutch, **measure time intervals by quarter cycles** from ½ cycle upward for circuit opening and circuit closing relays. Write for Bulletin 158. EW-2

Write for information on these other STANDARD Products:

Precision Timers (many models) Bulletin 153
Laboratory Time Standards Bulletin 95
Watthour Meter Test Benches and Laboratory Panels Custom Built
Electric and Chrono-Tachometers Booklet 151
Electric Clock and Program Systems Bulletin 131

Please mention this publication when writing.

THE *Standard Electric Time Co.*
SPRINGFIELD 2 STANDARD FOUNDED 1884 MASSACHUSETTS

Since 1923

SUPERIOR
SWITCHBOARD & DEVICES CO.
CANTON, OHIO
A Subsidiary of The Union Metal Manufacturing Co.

Quality meter testing and installation equipment

school of instrumentation in Philadelphia. Enrollments closed August 1 for the first 1947-48 term which opens on September 15.

Classes for the fall semester will be made up of engineers and instrument staff members of customers of the industrial division of Minneapolis-Honeywell Regulator Co. The group will include representatives from China, India and other countries.

•

Conlon Has Self-Teaching Course for Ironer Buyers

A system of instruction which will allow the purchaser of a Conlon automatic ironer to study in the privacy of her home has been introduced by the Conlon Corp, Chicago.

The course, called the "Conlon Personalized Home Training Course," consists of four 12-in. records and an illustrated, easel-type visual guide. The records and pictures are keyed together and are synchronized with actual ironing.

The housewife is loaned the instruction course by the retailer. She can use it until she becomes proficient in operating the ironer. The course allows her to practice without anyone watching her and at any time which is convenient for her.

Retailers gain because the time needed for demonstrating the ironer is reduced, not so many demonstrators are needed, and salesmen can use the course as a selling point.

•

Announce Name Change for Fire Extinguishers

A new and revolutionary change in name for the complete line of General portable fire extinguishers has been announced by the General Detroit Corp, Detroit. The new name, Quick Aid Fire Guard, will be applied uniformly to all types of portable fire extinguishers manufactured by The General Detroit Corp and its subsidiaries, The General Pacific Corp and the General Detroit Corp, Canada, Ltd.

The new name, Quick Aid Fire Guard, will be applied uniformly to all types of portable fire extinguishers manufactured by The General Detroit Corp and its subsidiaries, The General Pacific Corp and The General Detroit Corp, Canada, Ltd.

Until now, General's eight types of portable fire extinguishers have borne the brand names of S.O.S. Fire Guard, CD-Sno Fog, Red Star, Hi-Test, Floafome, Alaskan, Protector and Pacemaker.

The completely new design of the

"THAT'S FOR ME!!!"

That's just exactly what the man said.

You've probably said it, too — as you leafed through the advertising pages of a current issue of THIS magazine.

It happens all the time — to every man who is on top of his job.

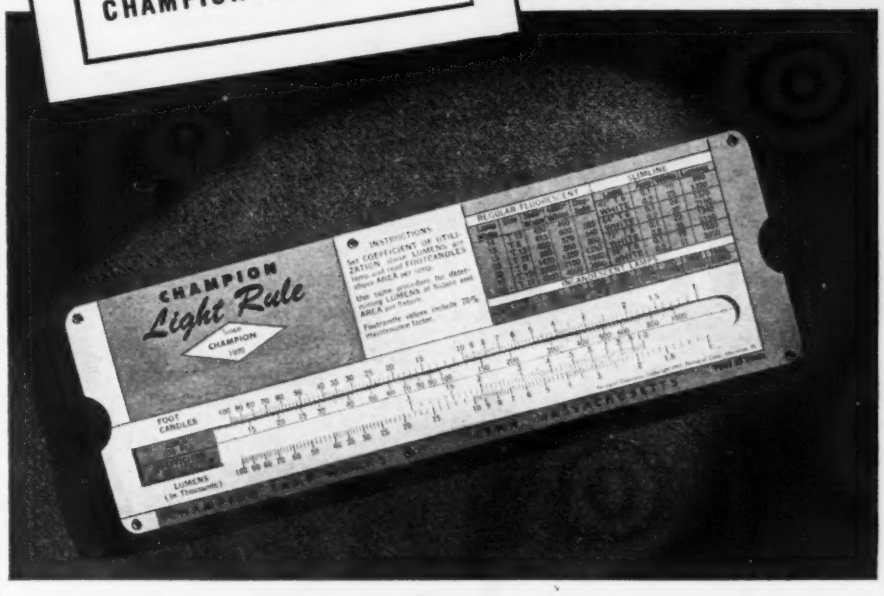
Why? Because he keeps a weather eye out for the things that promise a better, faster, more economical way of doing something.

He knows that America's leading manufacturers take the newest and best of their products and services to market in the advertising pages of the business and industrial magazines that help him keep on top of his job. And if *it's for him* he wants to know what makes it tick.

To keep in touch with the parade------
READ THE ADS.

With the Compliments of the
CHAMPION LAMP WORKS

One To Each Electrical World Reader

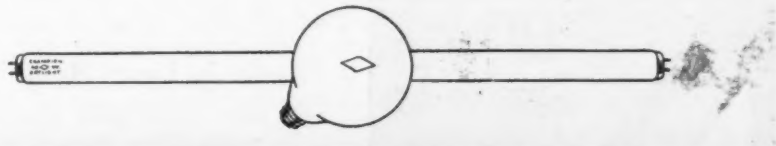


A CHAMPION *Light Rule*
The New, Simplified Lighting Calculator

Write today, on your company letterhead, and the makers of CHAMPION Quality **Fluorescent** and *Incandescent* Lamps will send you one of these handy, useful, pocket Light Rules.

Completely new and different, the Champion Light Rule gives you foot candles, lumens per lamp or fixture, area per lamp or fixture at a single setting of the slide. It's the only Lighting Calculator that applies to any type of lamp or fixture without reference to catalog numbers.

You'll have to see and try out this Light Rule to appreciate its practical utility. It's yours for the asking when requested on your company letterhead. Write Department M.



CHAMPION LAMP WORKS
Lynn, Massachusetts
A DIVISION OF CONSOLIDATED ELECTRIC LAMP CO

PIERCE
Amazing
SCIENTIFICALLY DESIGNED
FUSE
LINK

Keeps
EQUIPMENT
OPERATING
during safe loads
(100% to 200%)

Blow points are accurately computed. Extra surface area carries away heat. Ruggedly built tubular bridge and screen ventilated case contributes to its efficiency and lasting good value.

FREE: Balanced Lag Link to inspect and test. Specify amperage, voltage.

Quick Aid Fire Guard name plates makes product indentification easier and operating instructions more legible.

•

Manufacturers Issue Earnings Reports

Among the electrical manufacturing companies that issued earnings reports are the following:

ANACONDA WIRE & CABLE—(Preliminary) Net income $4,638,251 for the first six months, equivalent to $10.99 a share and contrasts with $578,949 or $1.37 a share earned in the six months ended June 30, 1946.

CUTLER-HAMMER, INC—Six months to June 30, net income, $1,562,105, after taxes, equal to $2.37 a common share, compared with $459,625, or 70 cents a share in the 1946 period.

MCGRAW ELECTRIC—Twelve months to June 30, net income $2,960,137, after charges and taxes, equal to $6.26 each on the 472,600 common shares outstanding, compared with $960,605, or $2.03 a share, in the preceding twelve months.

JOHNS-MANVILLE—Including subsidiaries, reported a record volume of sales, with the total of $33,613,580 for the three months ended June 30. This was 50 percent larger than the $22,501,030 volume for the second quarter of 1946. Sales for the first six months of 1947 increased to $63,401,038 from $35,456,834 for the corresponding period a year ago. Consolidated net earnings for the second quarter ended with June amounted to $2,938,645, or $1.01 a common share, compared with $1,738,101, or 62 cents a common share, for the similar three months of 1946.

CARRIER—Twelve months to July 31, net profit, $2,378,744, including tax carry-back credits, equal to $3.62 each on 590,578 shares of common stock, after preferred dividends, contrasted with a net loss of $1,205,875, before tax carryback credits, in the twelve months to July 31, 1946.

SERVEL, INC—Three months to July 31, net profit, $973,107, equal to 52 cents each on the 1,726,926 shares of common stock, after preferred dividends, compared with $781,324, or 41 cents a share in the three months to July 31, 1946. Nine months ended on July 31, net profit, $897,396, equal to 40 cents a share, contrasted with a net loss of $374,995 for the nine months to July 31, 1946.

YORK—Nine months ended on June 30, net earnings, $1,633,987, or $1.62 a share, compared with $791,062, or 85 cents in the 1946 period. Net sales, $31,928,125, against $23,241,448.

•

"Radio in Every Room" Film

A new sound slide film, showing radio retailers how to cash in on the "radio in every room" campaign of the Radio Manufacturers Association, is now available for local showing, RMA has announced. The 35-mm Kodachrome strip, entitled "Let's Get Personal," runs twelve minutes.

WHERE HAZARDS ARE GREAT

Wherever an industry requires the storage or handling of materials capable of bursting instantaneously into an intense and devastating fire, the utmost in fire protection is none too good.

Blaw-Knox Aquatomic Fog Nozzles stop "bad fires" at the start.

These dependable non-clogging and hard hitting Fog Nozzles cool and quench sudden fires in mere seconds.

Install Aquatomic Fog Nozzles where the hazard is the greatest for 100% dependable protection.

Also—

Blaw-Knox offers Standard Wet and Dry Pipe Systems, as well as Thermostatically Controlled Pre-Action and Deluge Systems.

Write for details.

BLAW-KNOX
SPRINKLER DIVISION
824 Beaver Avenue, N.S.,
Pittsburgh 12, Penna.

How to design, install and service FLUORESCENT LIGHTING SYSTEMS

New 2nd Edition

of this standard manual now brings you the latest information on new types and sizes of fluorescent lamps, auxiliary equipment improvements, recent lighting techniques.

Here is a complete and practical manual on fluorescent lighting, supplying you with the most up-to-date and authoritative information available on construction and performance of all types of fluorescent lamps. The manual presents the principles and methods of calculating illuminating requirements and designing luminaires and installations, methods of installing and maintaining fluorescent lamps, and of remedying their troubles. Included are working data, comparative cost factors—everything to aid you in achieving the most efficient and satisfactory fluorescent lighting systems.

Just Published!

FLUORESCENT LIGHTING MANUAL

By CHARLES L. AMICK

Lamp Department, General Electric Company, Nela Park Engineering Division
Second Edition, 318 *pages*, 6 x 9,
210 *illustrations*, 54 *tables*, $4.00

This new second edition of a highly successful manual brings all the information completely up-to-date. It contains much valuable new material, such as: data on the new Slimline and Circline fluorescent lamps; explanation of the fundamental factors in fluorescent lamp design and of the new glare rating system; information on lighting design; illustrations of modern fluorescent application.

10 chapters supply complete information on:

1. The Fluorescent Lamp
2. Auxiliary Equipment
3. Operating Characteristics
4. Installation Hints
5. Service Suggestions
6. Luminaire Selection
7. Fluorescent Lighting Design
8. Color Quality
9. Fluorescent Applications
10. Lighting Economics

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Send me Amick's Fluorescent Lighting Manual for 10 days' examination on approval. In 10 days I will send $4.00, plus few cents postage, or return book postpaid. (Postage paid on cash orders.)

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Collyer Wires and Cables meet every need of the building trade: they fully conform to all N.E.C. and Underwriters Standards, and are known for long life and ease of installation.

RUBBER INSULATED BUILDING WIRE

Braids are impregnated and finished for flame and moisture resistance. Specify Type R for dry locations and temperatures up to 50° C.; Type RH insulated with heat resisting synthetic rubber, for temperatures up to 75° C. Available in braided or lead covered construction for voltages to 5,000 or higher with sizes #14 to #8 solid or stranded, size #6 and larger, stranded.

VARNISHED CAMBRIC INSULATED POWER CABLES (Type V)

These cables require less space and, due to higher safe operating temperatures, carry heavier current loads for a given conductor. High dielectric strength and long life of varnished cambric make these cables preferred for high quality construction. Available braided or lead covered, single or multi-conductor, for voltages up to 15,000; operating temperatures to 85° C.

RESISTOL SYNTHETIC RESIN INSULATED WIRES

Resistol insulation is highly resistant to sunlight, ozone, acids, oils, moisture, etc., and in Type T and TW is approved for general service up to 600 volts and temperatures to 60° C. Having no fibrous covering, this thin wall insulation gives smaller finished diameters and permits more conductors to be carried in a given size of conduit. Available in sizes #14 to 1,000,000 C.M.

The Collyer line is complete. Let us know your requirements.

Collyer INSULATED WIRE CO.
245 Roosevelt Ave., Pawtucket, R. I.

Safe
Working Equipment
For The
Electric Industry

Glove Bags

Worn attached to the body belt. Keeps rubber gloves protected and within reach for when needed. Standard equipment with many Utility Companies.

Tool Buckets

The safe way to hoist and lower tools, insulators and other supplies. Saves time and materials. 12" dia. by 15" high. A standard for over twenty-five years.

Hi-Boy Swing Sign

For Street and Highway Use

Will not blow over leaving your men and the public unprotected. Attractive and attention arresting. 45" high in service (excluding flags). Folds compactly to 1¼" thickness for storing.

Other Products Include

Linemen's Gloves . . . Protectors . . . Climbers Straps and Pads . . . Wet Weather Suits . . . Ladder Shoes . . . Insulated Tools . . . Flag Tripods . . . Insulated Cleaning Brushes.

WRITE FOR CATALOG EW-97

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Safety Equipment for all Industries
INDUSTRIAL PRODUCTS COMPANY
2808 N. FOURTH STREET • PHILADELPHIA 33, PA.

Recent Rate Changes

UNION LIGHT, HEAT & POWER CO, Covington, Ky., has been authorized by the state Public Service Commission to make electric rate reductions for industrial, residential and commercial users in small communities in Boone, Campbell and Kenton Counties. The cut in charges for smaller towns and rural consumers was designed to bring rates more in line with the larger communities of Covington and Newport. Reduction for smaller communities and rural consumers in the three counties for residential lighting will total about $27,722 a year and for commercial lighting and small power $6,709 annually. The proposed reductions, submitted by the company, became effective September 1. Towns affected include Southgate, Woodlawn, Bromley, Park Hills, Fort Mitchell, South Fort Mitchell, Winston Park, Lakeside Park, Erlanger, Elsmere, Florence, Highland Heights, Alexandria, Cold Springs, Fort Wright, Lookout Heights, and Wilders.

VIRGINIA ELECTRIC & POWER CO's electric customers in North Carolina will save approximately $100,000 annually through schedules filed recently by the company, which became effective September 1. The commission obtained the lower schedules, which are the same as the Virginia rates, through negotiations with the company. The State Corporation Commission of Virginia had ordered the lower rates for Virginia. The North Carolina board insisted that the parity in the Virginia and North Carolina rates, which had existed for years, should be continued. The domestic rates schedule was the only schedule changed. The reduction on all other schedules were made through a rider providing for a 5 percent reduction on monthly bills. This rider is a temporary measure and will automatically expire on August 31, 1948. The total reduction to the company was estimated at $1,400,000 annually. The new domestic schedule will give a customer 100 kwhr for $3.75. The present charge is $3.95. The new domestic schedule will save approximately $23,000 a year to North Carolina users. The discount rider will save business and industrial users about $82,000 a year.

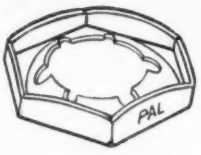
SOUTHERN CANADA POWER CO's commercial and industrial customers, many of them textile manufacturers will save $300,000 a year under a reduction in rates, effective October 1. While the exact rates are not yet known, it is believed that commercial rates will be reduced approximately 10 percent. The area served by Southern Canada Power is south of the St. Lawrence to the American border. Domestic users had a reduction a few years ago, and they will not be affected by the decrease.

CLASKANIE (ORE.) PUBLIC UTILITY DISTRICT has reduced rates to the amount of 13 percent of the gross revenue and 34½ percent of the net revenue of the PUD, effective September 1. Earnings amounted to $32,399 in 1946 and $18,007 for the first six months of 1947.

•

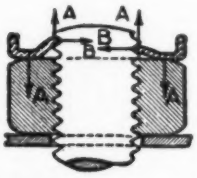
Opens Plant in Georgia

Kinsey Electric Co, manufacturers of transformers, has opened a plant at Fairburn, Ga., which eventually will employ from 50 to 100 persons.



Palnut Self-Locking Nuts are inexpensive, single thread, tempered spring steel locknuts — easily, speeedily spun on top of regular nuts with the fingers, locked tight with a wrench.

***DOUBLE LOCKING ACTION**
Arched, slotted jaws grip the bolt like a chuck (B-B), while spring tension is exerted upward on the bolt threads and downward on the regular nut (A-A), securely locking both.



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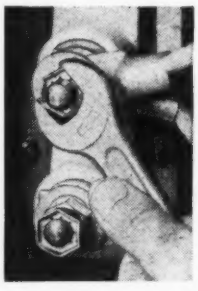

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BOOK REVIEWS

Klystron Tubes. By A. E. Harrison. Published by McGraw-Hill Book Co, New York. 271 pages, illustrated. Price $3.50.

Klystrons are microwave tubes that rely upon electron bunching to convert a velocity modulated beam into a varying current. They facilitate attainment in the microwave region of the functions of conventional triodes and pentodes. The book is essentially a treatment of the theory; the later chapters deal with the techniques of operation, the matter of power supply and the applications of Klystrons.

Fundamentals of Naval Warfare. By Lee J. Levert. Published by The Macmillan Co, New York. 488 pages, illustrated. Price $5.

There are at least ten chapters out of the 70 that should prove of interest to the engineer specifically desirous of familiarizing himself with naval power requirements, propulsion, mobility, communications and control, gyroscope and electronic devices, bearing and ranging, radar and fire control. But there were thousands of engineers who left the electrical industries to take up special duties with the Navy and most of them had no chance to understand the correlation of weapons, ships, engineering tactics and strategy. Here is afforded an opportunity to satisfy that desire because the Consolidated Edison engineer who wrote it not only had a very versatile training and career in the Navy but he has a knack for making the naval battles of history intensely interesting. If the reader is convinced that naval preparedness is one way to avert war he will have become one of the converts Commander Levert hopes to win.

Air Conditioning and Elements of Refrigeration. By S. P. Brown. Published by McGraw-Hill Book Co, New York. 644 pages, illustrated. Price $6.

Since the material was assembled for a vocational course the preparatory treatment is elementary, but this should be a virtue for the technically untrained reader. After treating the properties of air and other gases, psychrometry, refrigerants and refrigerating equipment, the chapters lead into comfort cooling, heating loads and year-round conditioning systems—each in a quantitative way. Subsequent sections deal with fluid flow, fans and pumps, ducts and piping, controls, air distribution. Appendices have comprehensive steam and psychrometric tables, refrigerant properties and coefficients of heat transmission of various wall and roof constructions.

The Rome Cable Manual of Technical Information. Published by Rome Cable Corp, Rome, N. Y. 263 pages, illustrated. Price $2.50.

This first edition has been geared to the reference needs of those who apply wire and cables for power or communication purposes. Scope can be inferred from the following sampling of contents: definitions, gage data, wire tables (copper, aluminum and steel), cable insulations, IPCEA current carrying capacities (47 tables), portable cables, shielding data, sagging, resistances and impedances, voltage drops, calculated cable diameters and reel capacities, audio and radio-frequency data, NEC data, properties of materials, power factor kilovars, fusing currents, relative humidity, conversion and mathematical tables. Advertising is confined to two or three pages.

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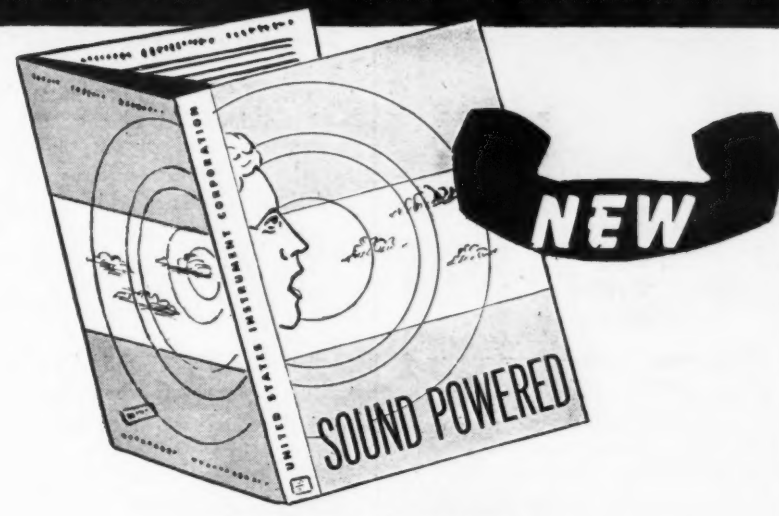

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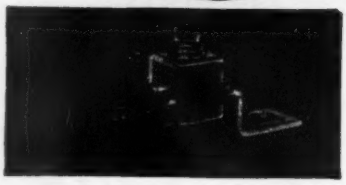

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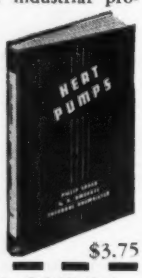

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LETTERS TO THE EDITORS

Transformer Var Absorption

To the Editor of ELECTRICAL WORLD:

I am impelled to comment on the excellent review of watt and var conceptions in power systems contributed by E. C. Goodale, which appeared in the July 5 issue of ELECTRICAL WORLD. These basic concepts are frequently used in our own thinking and they simplify power system operation considerably.

An error, typographical perhaps, has crept in, however, where the statement is made that a transformer absorbs vars "in proportion to its percent reactance times percent load." This statement should, of course, read, "its percent reactance times the *square* of the percent load." Transformers, or any other inductance, will, of course, absorb only one-quarter of the vars at one-half load that they absorb at full load.

William Joseph
Electrical Engineering Division
American Gas & Electric Service Corp.
New York

[Mr. Goodale's untimely death while the article was awaiting publication prevents the customary reply from the author. It appears that Mr. Joseph is correct in his contention. — The Editors]

Drying Ink Electrically

To the Editor of ELECTRICAL WORLD:

I am writing to comment on your editorial, "Can You Do It Better With Gas?," which appeared on page 82 of your May 10 issue.

To be very blunt, I feel that the writer of this editorial did not have sufficient information at hand to be qualified to write on this subject. I do not wish to be considered an authority, but I have had considerable experience with our customers on this problem and have also discussed it with utility men in other areas. I believe that the problem is not one of supplying sufficient heat to dry printer's ink, but is the fact that oxidation is required to dry the oils that are used in almost all such ink. Electricity supplies pure heat but does not supply the oxidizing effect which is required to dry this material. Apparently open gas flames do supply this effect, and it is for this reason that gas is generally used in this process. I believe that electric heat

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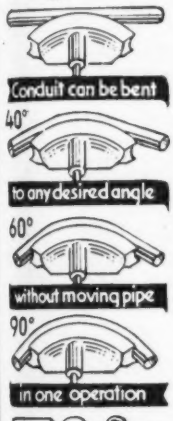

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will be able to do this job best when inks are developed which dry by polymerization or by evaporation of a solvent.

I also question your statement that the radiant heat from electricity "goes through the ink and heats the paper underneath" and I would be interested in knowing where the authority for this statement can be found. I feel that the penetrating effect of infrared has been greatly overemphasized and that much of the energy would be absorbed by the first material which intercepts it. In any case, I feel that the radiant energy would be sufficient to dry the ink if the ink required only heat to dry it.

For your information, the Commonwealth Edison Co in Chicago has done a great deal of experimental work on drying ink with electricity, and I suggest that you contact them for authoritative information. They may not agree with me, but I think you would be interested in knowing what they have to say.

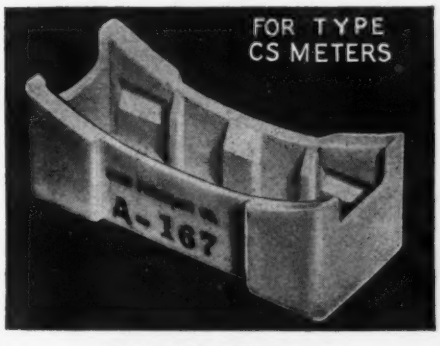
William H. Wagner,
Industrial Heating Engineer
Wisconsin Electric Power Co

[Editor's Note: Statements in the editorial were not those of the editor who wrote it, but of the authority on printing mentioned in it. The Chicago experiment referred to by Mr. Wagner is the subject of an article published in ELECTRICAL WORLD of August 2, 1947. Note also that gas flames are not usually oxidizing, actually they have the opposite characteristic, that is, they are reducing or lacking in oxygen.]

Longer Life Lamps

To The Editor of ELECTRICAL WORLD:

In the interval between the writing and the publication of Mr. R. M. Swetland's article, "Today's Mercury Lamp For Street Lighting," that appeared in ELECTRICAL WORLD of May 10, 1947, improvements were affected in the F-HI



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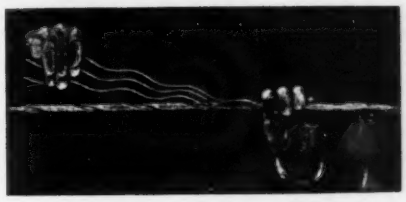

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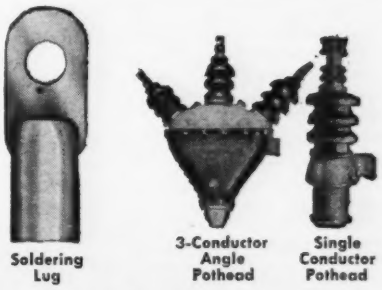

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[For mis-judging the pace of progress in the lighting art ELECTRICAL WORLD bows a humble head.—The Editors]

Off Peak Load Control

To the Editor of ELECTRICAL WORLD:

The article in your July 19 issue by Mr. W. H. Berning on "Value of Water Heater Time Control Questioned" adds pertinent data to that which has been accumulating in the hands of utility men for some time. If utilities were limited to the use of time switches, quite likely the attractive prospect of eliminating time switches might even lead to abandonment of all such control by some companies.

Fortunately control of water heating, or any other load, off peak or otherwise, is now being done economically and reliably whereby such loads can be thrown on and off at the will of the operator or automatically, as peak loads approach and recede. Production of equipment for that purpose is increasing very rapidly, indicating the prevalence of the thought behind Mr. Berning's article.

Very truly yours,
Verne W. Shear
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•

High Towers Opposed

Plans of the British Columbia Electric Railway Co for bringing power from its new development at Bridge River to a central distribution area in the east end of Vancouver are being opposed by the city. The utility planned to use towers 120 ft high to carry 220-kv lines. City officials feel that these towers would lessen property values. A further study is being made.

•

Would Buy Systems

Appalachian Electric Power Co plans to take over the distribution systems in five coal communities in southern West Virginia. The communities are Long Branch, Pax, Bartley, Raysall, and Puritan mines. Appalachian would buy the systems from coal companies for a total of $16,263.45.

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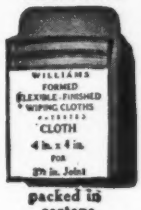

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SALARIED POSITIONS $2,500-$25,000. This thoroughly organized confidential service of 37 years recognized standing and reputation carries on preliminary negotiations for supervisory, technical and executive positions of the calibre indicated; through a procedure individualized to each client's requirements. Retaining fee protected by refund provision. Identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 262 Dun Bldg., Buffalo, N. Y.

EXECUTIVE AND Technical Men—since 1915 thousands have used our confidential personnel service with success in contacting employers for desirable positions. We handle all negotiations. Send experience record with inquiry. The National Business Bourse, 20 W. Jackson Blvd., Chicago 4, Ill.

EXECUTIVES $3,000-$25,000. This reliable service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. C, 109 Church Street, New Haven, Conn.

POSITIONS WANTED

DISTRIBUTION ENGINEER, available graduate, 23 years experience, design, studies, planning, and estimating. Thoroughly familiar with construction, operation, maintenance and standards development. PW-1789, Electrical World, 520 N. Michigan Ave., Chicago 11, Ill.

GENERAL FOREMAN Electrical. Experienced in operation, maintenance, and construction of hydro-electric power plants and systems. Generation to 130,000 KW, transmission to 230,000 V, metering, relaying electrical and hydraulic control. PW-1779, Electrical World, 68 Post Street, San Francisco 4, Cal.

DISTRIBUTION ENGINEER Available — Twenty years overhead and underground experience. Member of AIEE. Veteran. Best of references. Prefer location in West or Southwest. Address communication PW-1765, Electrical World, 520 N. Michigan Ave., Chicago 11, Ill.

ELECTRICAL GRADUATE. Age 46. Now permanently employed. Interested in changing location. Desires new permanent connection in supervisory or sales capacity. Thirteen years electric utility experience in distribution and contact work. Eight years manufacturing design experience. PW-1799, Electrical World, 330 W. 42nd St., New York 18, N. Y.

SELLING OPPORTUNITY WANTED

EXPERIENCED ENGINEERS and Sales representative now in position to represent manufacturers of electrical and mechanical equipment for public utilities, municipal plants and industrials; territory North and South Carolina. RA-1654, Electrical World, 330 W. 42nd St., New York 18, N. Y.

OFFICIAL PROPOSAL

(103)

Electric Generator Plants

The Iraq embassy, 3141 - 34th Street, N.W., Washington, D. C., invites bids on a quantity of *100* complete diesel engine driven electric generator plants to meet with the following general specifications: (Detailed specifications available upon request).

Diesel Engine:

Four stroke cycle, water cooled, engine speed not exceeding 1000 R.P.M. complete with all starting, operating and functional accessories including fuel service tank and exhaust muffler—all suitable for high ambient and tropical operation.

Alternator:

Direct connected type. Output between 40 k.w. and 60 k.w. (50 kva and 75 kva at .8 p.f.) with adequate overload capacity at 120°F. ambient temperatures. Alternating current three phase, fifty cycles, 400/230 volts.

Switchboard:

Complete electric switchgear including automatic voltage regulator, circuit breaker, synchronising device, meters, switches, etc. necessary for satisfactory operation of set.

Tools:

Complete set of tools and essential spares.